UNIT 1

Introduction to Analog Electronics

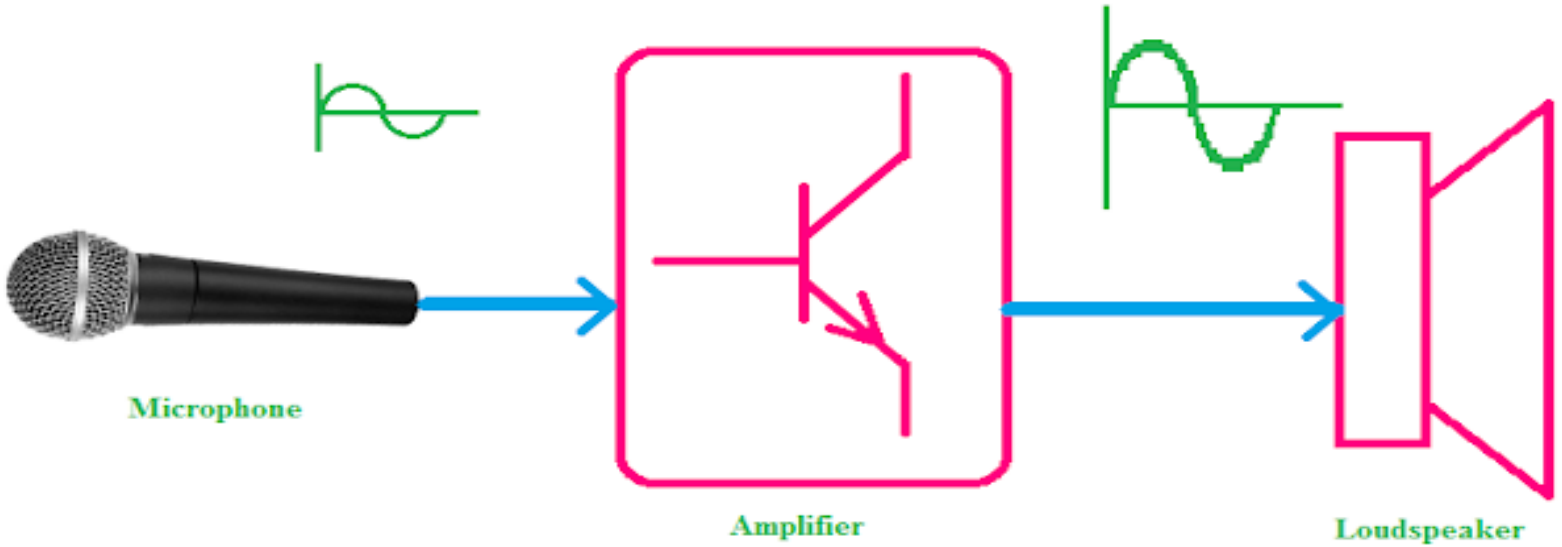
Session-3

Transistor Amplifier: CE amplifier

Transistor Amplifier: CB and CC amplifier

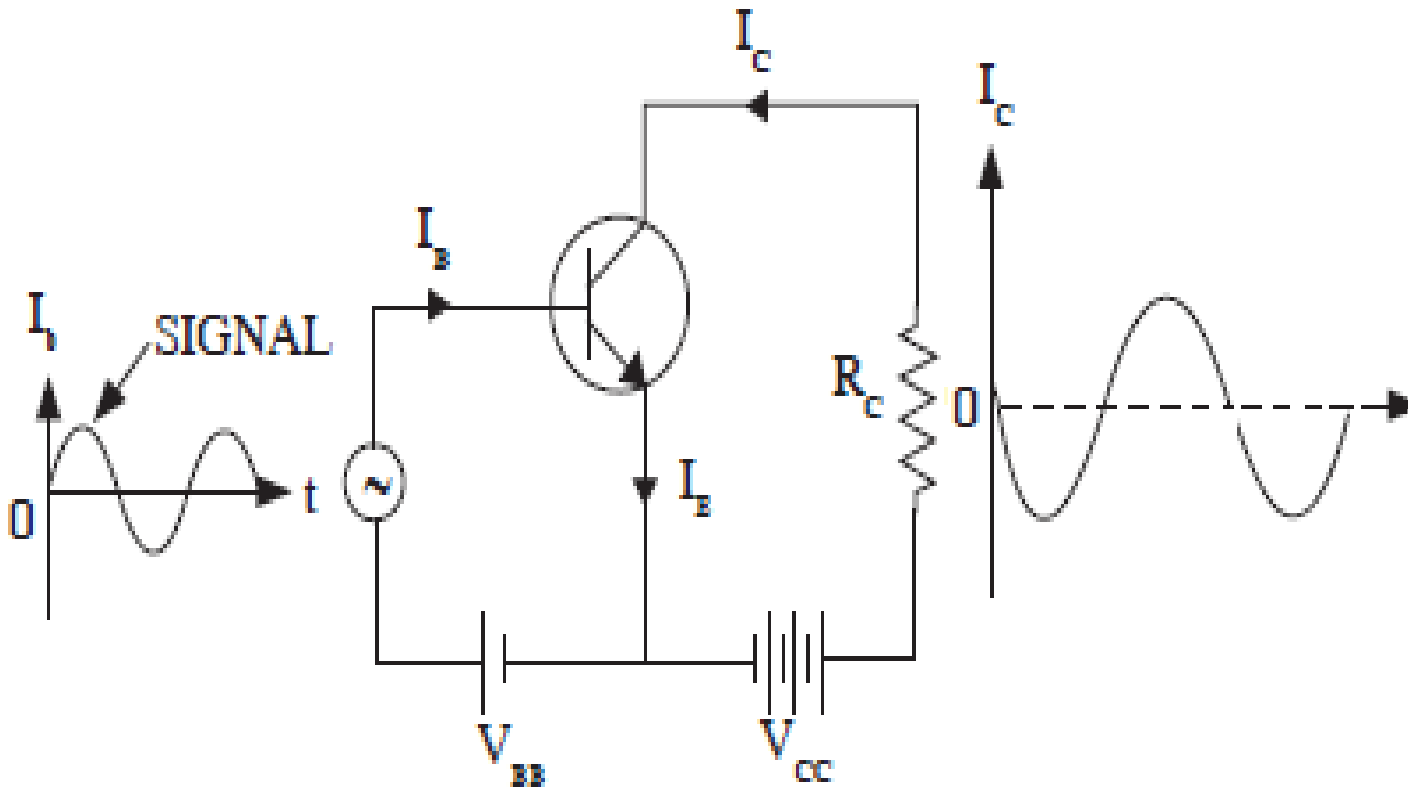
Transistor Amplifier

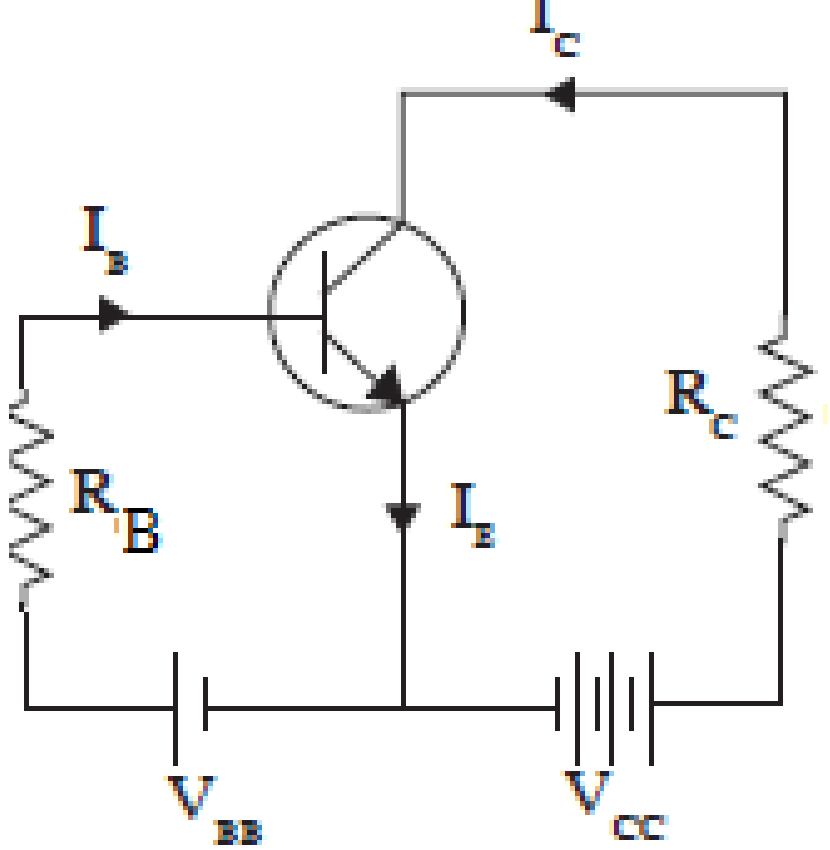
- The transistor raises the strength of a weak signal and hence acts **an amplifier**
- **The transistor works as an amplifier in all configuration (CE, CB and CC)**



Transistor Amplifier: CE amplifier

- **npn** transistor in CE mode
- Input between Base and Emitter
- Output between Collector and Emitter
- Input current $\mathbf{I_B}$
- Output current $\mathbf{I_C}$
- Input junction (BE)-forward biased
- Output junction (CE)-Reverse biased
- The V_{BB} battery provides the forward bias
- The V_{CC} battery provides the reverse bias





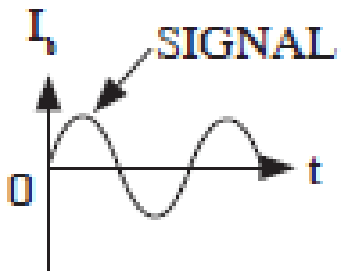
Write KVL in Input circuit

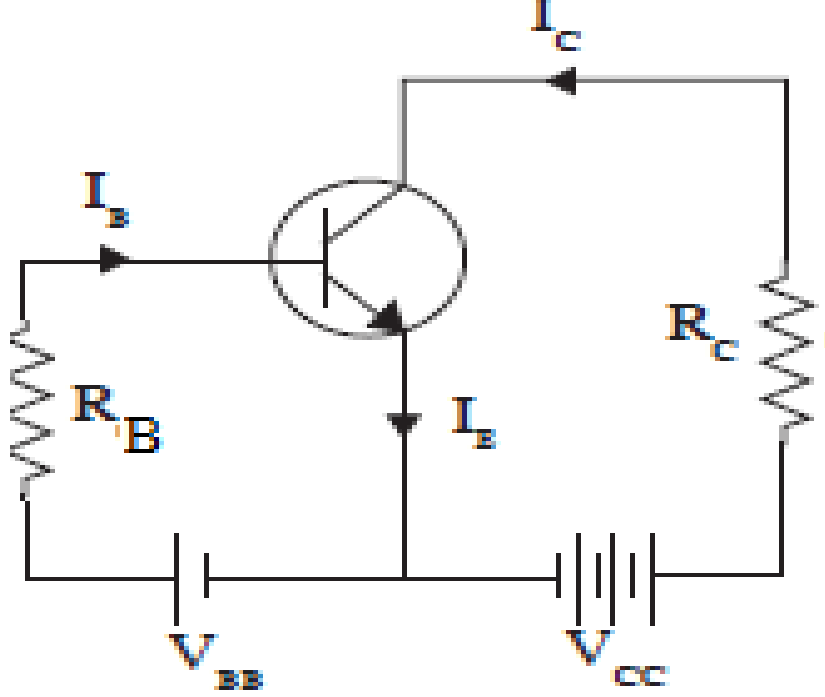
$$V_{BB} = I_B R_B + V_{BE}$$

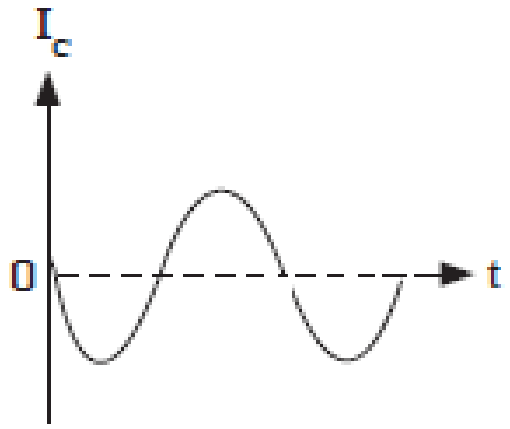
Write KVL in output circuit

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

$V_{BB}+V_I$



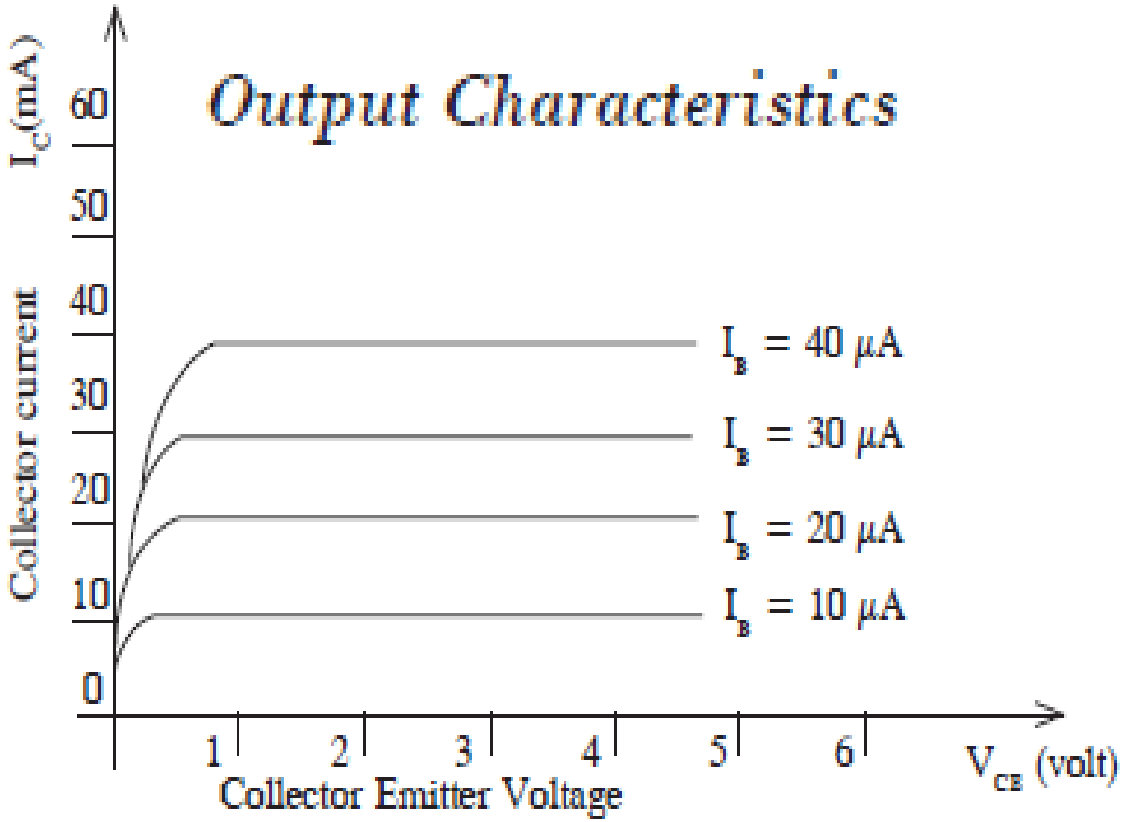




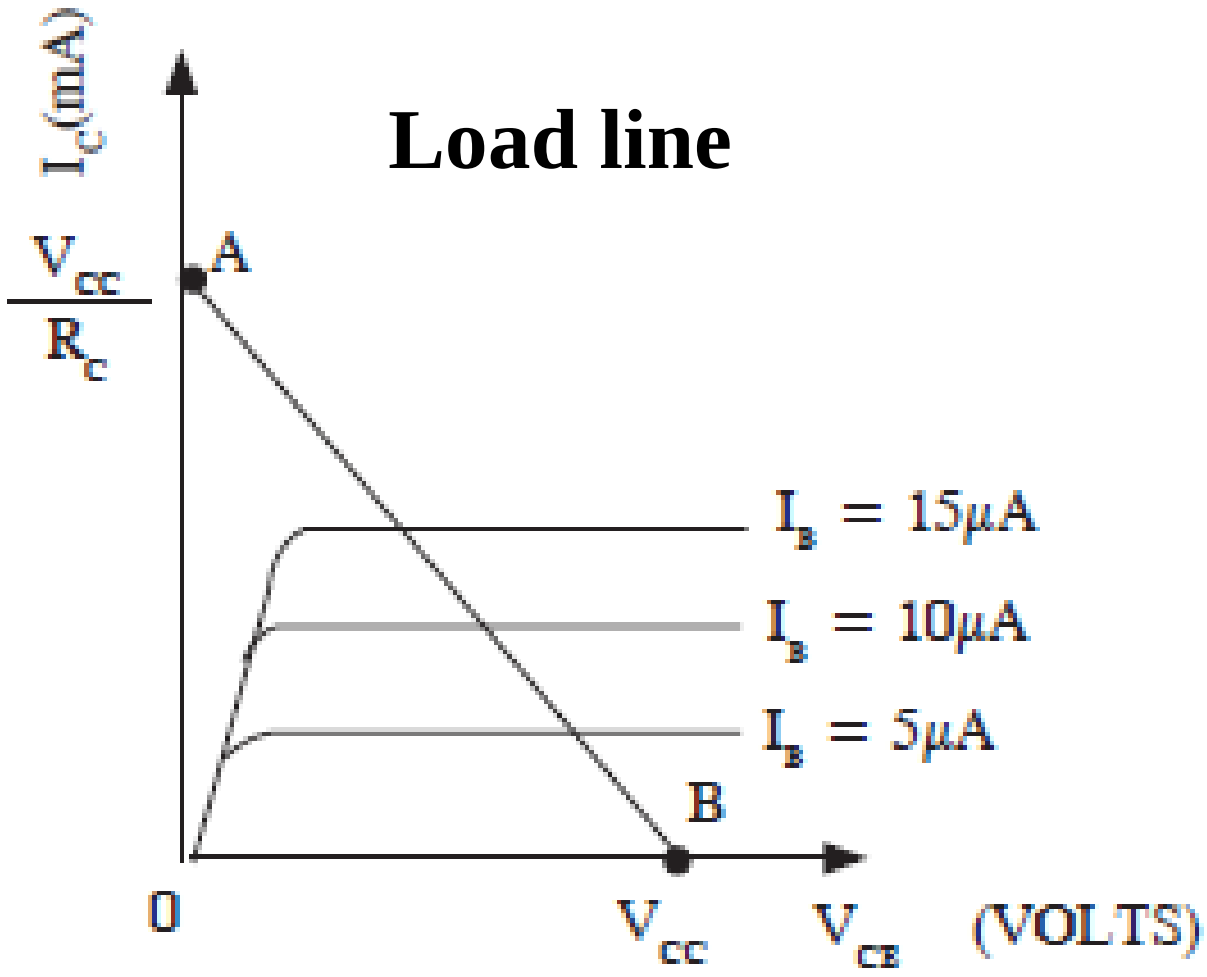
$$V_{CE} = V_{CC} - I_C R_C$$

Link between input and output current

- I_B increases I_C increases
- I_B decreases I_C decreases
- Variation in collector current gives variation in output voltage
- Transistor works as a amplifier in proper operating point



Load line



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

$$V_{CE} = 0$$

$$I_C(sat) = V_{CC}/R_C$$

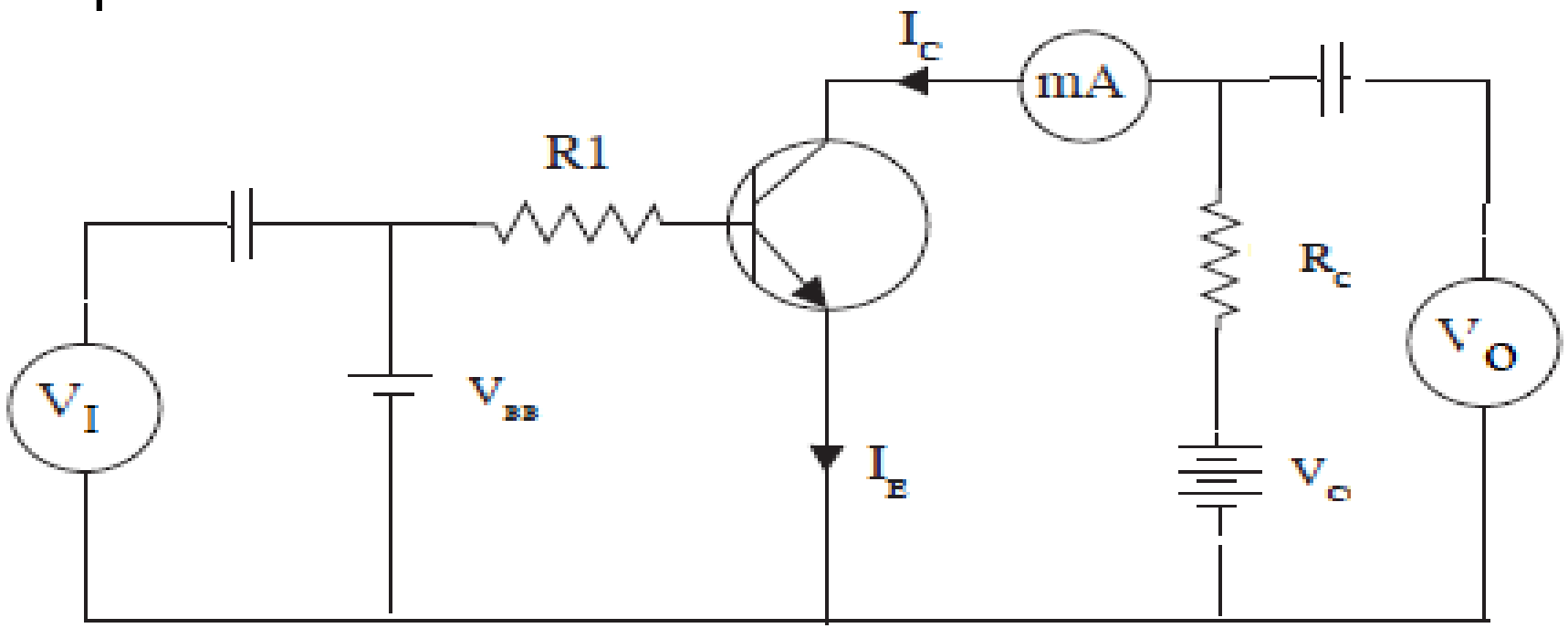
$$V_{CE} = V_{CC} - I_C R_C$$

$$I_C = 0$$

$$V_{CE\,Max} = V_{CC} \text{ or } V_{CE}(Cut) = V_{CC}$$

- Each point of load line is the operating point of a transistor

Amplifier



- Capacitor connected to the input and output side remove **DC component**

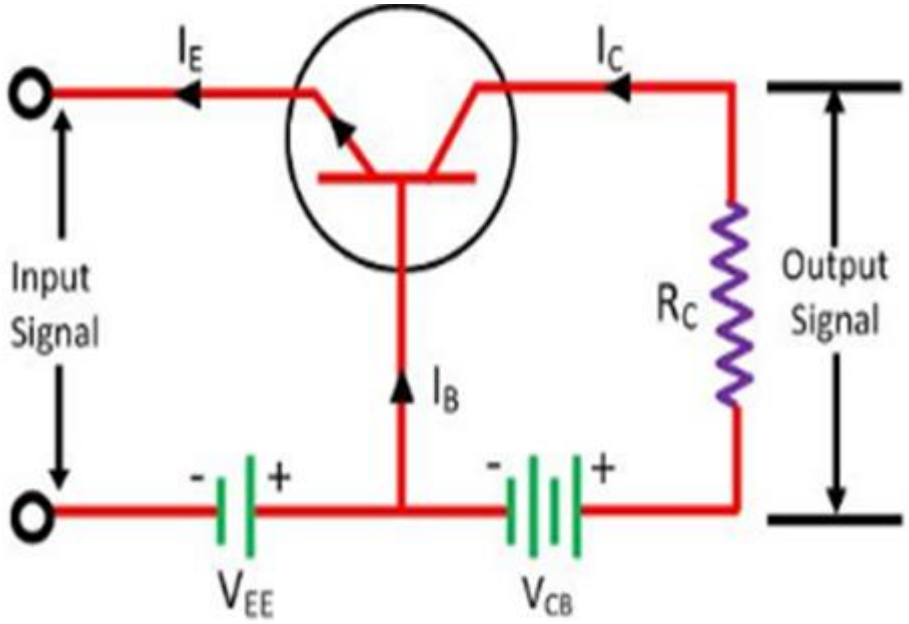
$$V_{CE} = V_{CC} - I_C R_C$$

- I_C increases : V_{CE} voltage decreases
  - Voltage gain $A_V = V_{CE}/V_I$

Operation of Common Emitter Amplifier

- When a signal is applied across the emitter-base junction during the positive half cycle the forward bias across this junction increases.
- This increases the flow of electrons from the emitter to a collector through the base, thus increases the collector current.
- The increasing collector current induces more voltage drops across the collector load resistor R_C.
- The negative half cycle decreases the forward bias voltage across the emitter-base junction.
- The decreasing collector-base voltage reduces the collector current in the whole collector resistor R_C.
- Thus, the amplified load resistor appears across the collector resistor

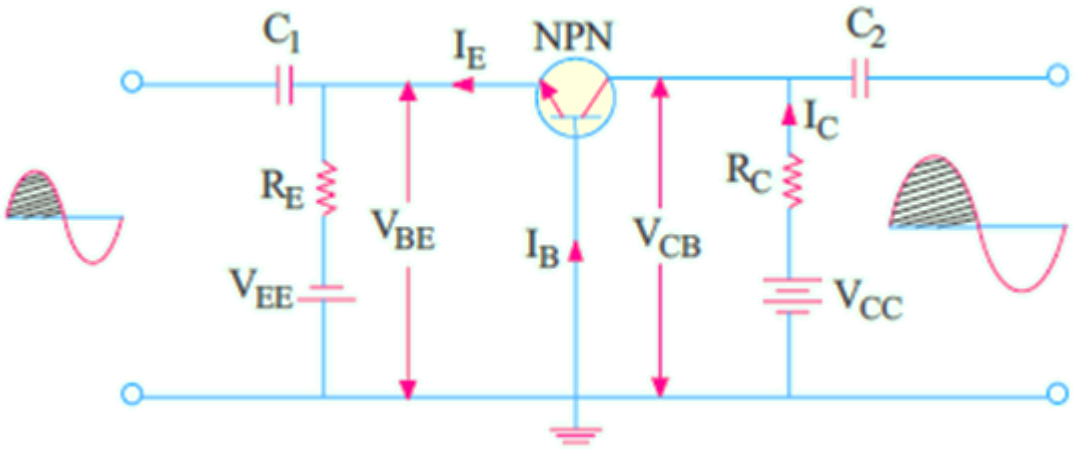
Common Base Transistor as an Amplifier



- The emitter and base of the transistor are connected in forward biased and the collector base region is in reverse bias.
- The input signal or weak signal is applied across the emitter base and the output is obtained to the load resistor R_C which is connected in the collector circuit.
- The DC voltage V_{EE} is applied to the input circuit along with the input signal to achieve the amplification

- When a weak signal is applied to the input, a small change in signal voltage causes a change in emitter current (or we can say a change of 0.1V in signal voltage causes a change of 1mA in the emitter current) because the input circuit has very low resistance.
- This change is almost the same in collector current because of the transmitter action.
- In the collector circuit, a load resistor R_C of high value is connected.
- When collector current flows through such a high resistance, it produces a large voltage drop across it.
- Thus, a weak signal (0.1V) applied to the input circuit appears in the amplified form (10V) in the collector circuit.

Common Base (CB) Amplifier

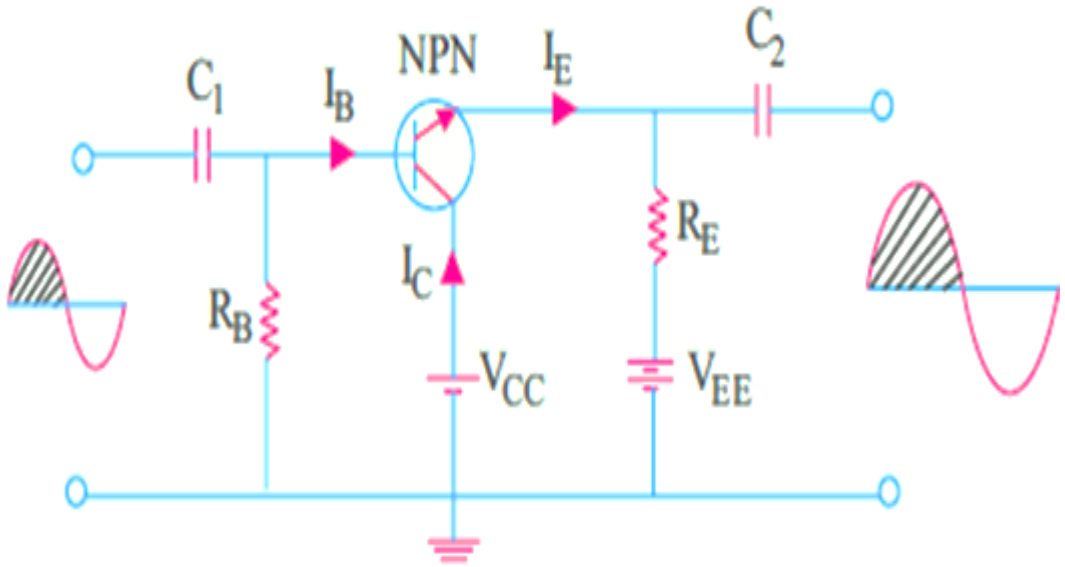


When positive half-cycle of the signal is applied, then

1. .forward bias is **decreased** because V_{BE} is already negative with respect to the ground
2. consequently, I_B is **decreased.**
3. I_E and hence I_C are **decreased**
4. The drop I_C R_C is **decreased.**
5. Hence, V_{CB} is **increased**

- Since a **positive-going** input signal produces a **positive-going** output signal, there is no phase reversal
- Voltage amplification in this circuit is possible by reason of relative input and output circuitry rather than current gain (α) which is always less than unity.
- The input circuit has low resistance whereas output circuit has very large resistance.
- Although changes in input and output currents are the same, the ac drop across RL is very large.
- Hence, changes in VCB (which is the output voltage) are much larger than changes in input ac signal. Hence, the voltage amplification.

Common Collector (CC) Amplifier



1. forward bias is **increased** since *VBE* is positive w.r.t. collector i.e. ground,
2. base current is **increased**,
3. emitter current is **increased**,
4. drop across *RE* is **increased**,
5. hence, output voltage (*i.e*. drop across *RE* is **increased**.

- When a **positive-going** input signal results in a **positive going** output signal and, consequently, the input and output signals are in phase