Transistor as a Amplifier

Transistors are can be configured in three different ways depending on whether the common terminal b/w the input and output ports is base, collector or emitter and are named common base(CB), common collector(CC) and common emitter(CE), accordingly.

These can be used as switches or amplifiers based on the choice of OPERATING POINT AND REGION OF OPERATION .For switching the transistor circuits when made to operate between cut-off and saturation regions and for amplifiers when made to operate in their active region.

In addition, it is to be kept in mind that the transistors are inherently nothing but the current-controlled devices wherein a small change in the base current, I_B results in a large variation in the collector current, I_C s.t.
($I_E=I_B+I_C$) .
Figure 1 shows a simple common emitter circuit which uses an npn transistor whose

- Collector terminal (output terminal) is connected to supply voltage V_{CC} through the collector resistor R_C.
- Base terminal is provided with the AC signal which needs to be amplified.
- Emitter terminal is grounded (hence also referred to as Grounded Emitter configuration).

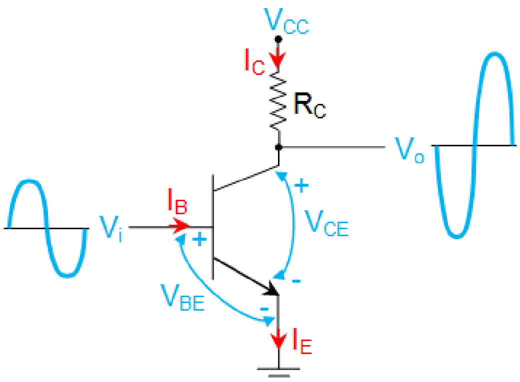

Figure 1 A Simple Common Emitter Amplifier

1). For 1st half of input signal, as the input voltage V_i increases, the base current I_B also increases which in turn increases the collector current I_C.
This causes an increase in the voltage drop across the collector resistor, R_C which results in a decreased output voltage V_0 as emphasized by the following relationship

$$V_0 = V_{CC} - I_C R_C$$

2). For the 2nd half of the input signal the input voltage goes on decreasing, I_B and hence I_C decrease, due to which the voltage drop across R_C also decreases thereby increasing the output voltage.
3). Thus for the positive half-cycle of the input waveform, one would get amplified negative half-cycle while for the negative input signal, the output would be a amplified positive pulse. Hence there exists a phase-shift of 180^{o} between the input and the output waveforms of the **common emitter amplifier** (***<u>also called as inverting amplifier).</u>***

<u>Faithful,Undistorted or practical amplifier</u>
However in order to obtain an faithful(undistorted) amplification gain the transistor needs to be biased properly by setting a suitable operating point (Q-point). This indicates that practically one has to resort to a stable network (Figure 2) which will be resistant to the changes in temperature and other transistor parameters.

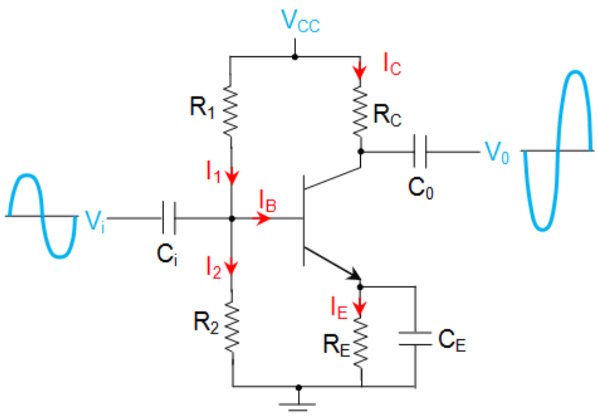

Figure 2 Common Emitter Amplifier with Biasing and Decoupling Details

CONSTRUCTION

1). The resistors R_1 and R_2 are used to provide bias for the base of the transistor (voltage-divider transistor biasing)

2).The emitter resistor R_E is used to ensure that proper DC conditions are maintained for the circuit by regulating the amount of DC feedback.

3). The capacitors C_i and C_o which are the decoupling capacitors used to provide AC coupling between the amplifier stages or blocks the DC from entering or leaving the ckt. The values of these capacitances are chosen to such that they provide negligible reactance at the frequency of operation.

OPTIONAL FOR STUDENTS may skip this technical settings(In particular, the value of the input capacitance C_i should be chosen to be equal to the resistance of the input circuit at the lowest frequency such that it results in a -3dB fall at this frequency. In addition, the value of the output capacitor C_o is chosen so that it is equal to the circuit resistance at the lowest operating frequency.))
Further the emitter voltage V_E is chosen to be 10% of the supply voltage V_{CC} to ensure a good level of DC stability and the current through R_1 which is I_1 is chosen to be 10 times the required base current. Here it is to be noted that, even I_2 will be of almost the same value as the base current I_B will be negligible.

4).The emitter bypass capacitor C_E when added into the circuit, increases its gain considerably by short-circuiting the emitter resistance R_E for high frequency signals, which results in the reduction of the overall transistor load. OPTIONAL(*The value of this C_E is chosen such that the capacitor offers a reactance value which is equal to the 1/10^th^ of R_E at the lowest operating frequency.)*

Mathematical expression β=gain factor for CE mode and A_V is Voltage gain.

$$\beta = \frac{I_C}{I_B}$$

$$and$$

$$A_V = \frac{V_0}{V_i} = -\frac{R_C}{R_E}$$

These **common emitter amplifiers** are most widely used, say for example as low noise amplifiers and radio frequency amplifiers, as they offer medium input resistance, medium output resistance, medium voltage gain, medium current gain and high power gain.

IMP: The analysis of the ckt by means of h(hybrid parameters is to be done from book). The discussion is quite explanatory. I wll not upload any other method/mathematical formulation to avoid confusion .will send pic of the same with written explanations wherever necessary.