

Transistor As a Common-Base Amplifier

Operation

When the emitter-base circuit is forward biased and the collector-base circuit is reverse biased; the emitter, base and collector currents will flow as shown in fig.

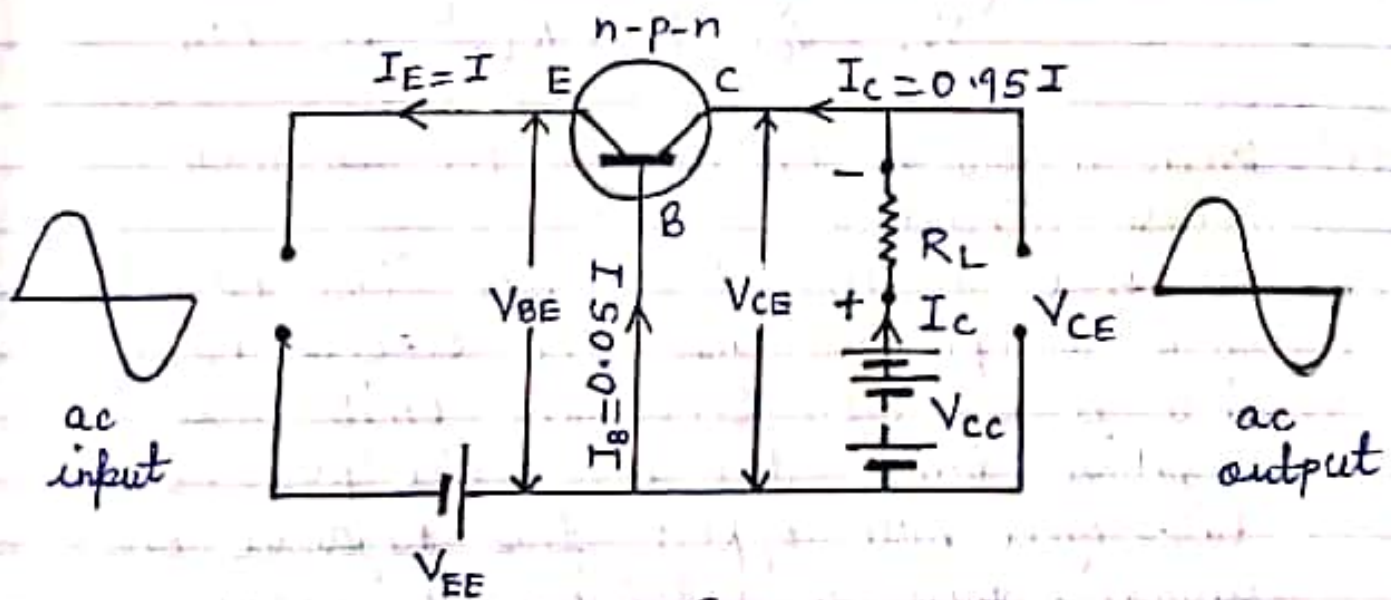


Fig.

Using an n-p-n transistor, note that the collector current (I_C) is 95% of the emitter-current (I_E), with the remaining 5% flowing in the base circuit, combining with the holes in the p-type base.

Thus, if $I_E = I$, $I_B = 0.05I$ and $I_C = 0.95I$.

(a) With no signal input : A certain collector current will flow, producing a voltage drop ($I_c R_L$) across R_L (the load resistance). As is evident, this voltage drop is in opposition to the collector battery voltage V_{cc} and such it places the collector voltage V_{ce} at some value lower than the battery voltage. Obviously,

$$V_{CE} = V_{CC} - I_c \times R_L \quad \text{--- (1)}$$

(b) With a signal applied to the emitter-base circuit :

We will assume that the first half cycle is positive and the second half cycle is negative. Since the emitter is negative w.r.t the base, the positive half cycle will oppose this negative bias voltage. With a reduction in forward bias, the emitter current will be reduced with consequent reduction of collector current. Since the collector current is reduced, the voltage drop across R_L , i.e. $I_c \times R_L$ is also reduced. Therefore, from eqⁿ (1), V_{CE} is increased, i.e., the collector will become more positive. Thus, as the

input signal varies through its positive half cycle, the output signal developed at the collector also varies through a positive half cycle.

During the negative half cycle, the emitter becomes more and more negative and the forward bias is increased. As ^{such} the collector current is increased and consequently the voltage drop across R_L also increases. Therefore from eqⁿ (1), V_{CE} is decreased i.e. the collector becomes less positive, i.e.; more negative.

We thus conclude that in a common-base circuit, the input and the output voltages are in phase, i.e., there is no phase reversal in voltage.

The dc current gain (α): It is ratio of the collector current (I_C) to the emitter current (I_E).

$$\text{That is, } \alpha = I_C / I_E \quad \text{--- (2)}$$

α is always less than one but values as high 0.98 have been attained.

The ac current gain (α_{ac}): It is defined as the ratio of change in collector current to the change in emitter current at constant collector-base voltage.

$$\text{That is, } \alpha_{ac} = \left(\frac{\Delta I_C}{\Delta I_E} \right)_{V_{CB} = \text{constant}} \quad \text{--- (3)}$$