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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.

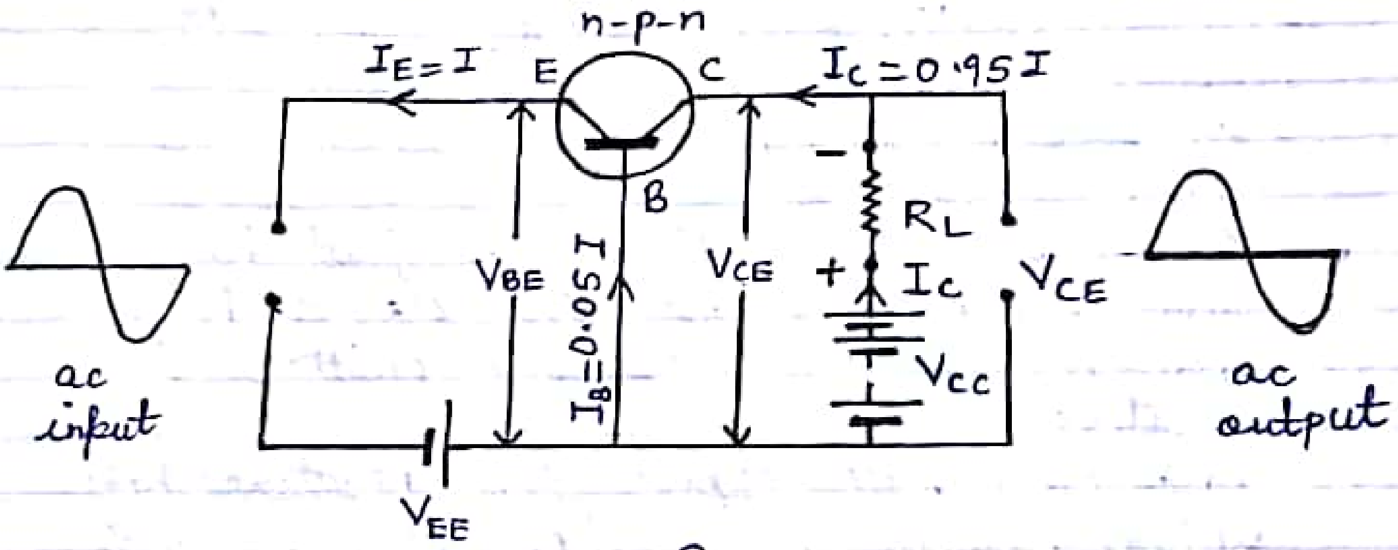

Fig.

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

(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 eq^n (i), 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 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).

That is, $\alpha = I_C/I_E$ — (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.

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