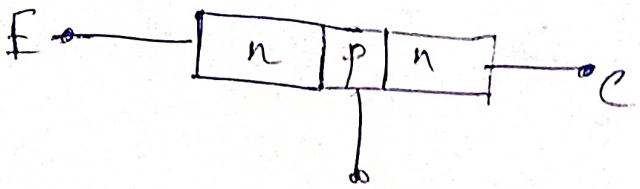
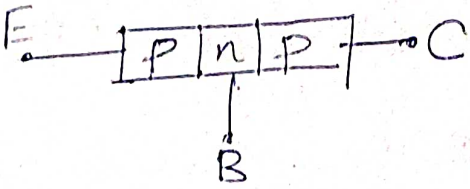
Transistor (Bipolar Junction Transistor - BJT)

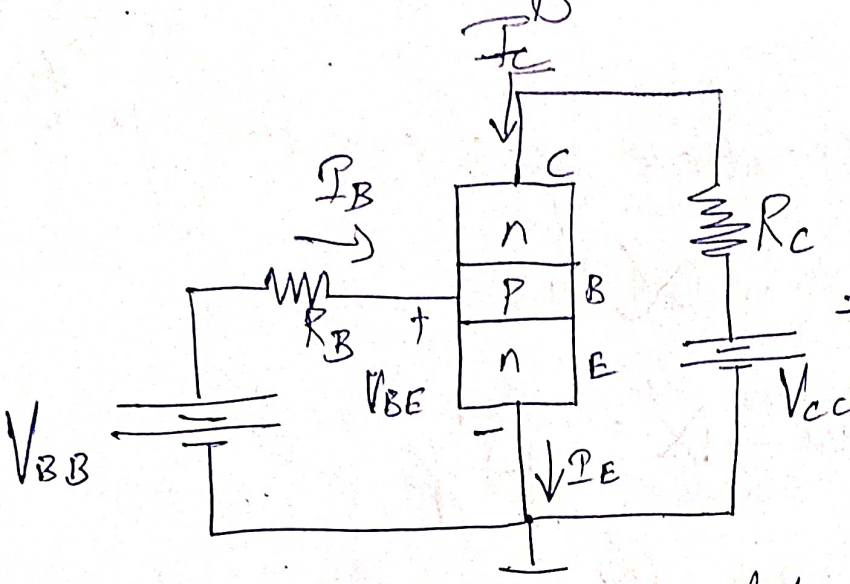
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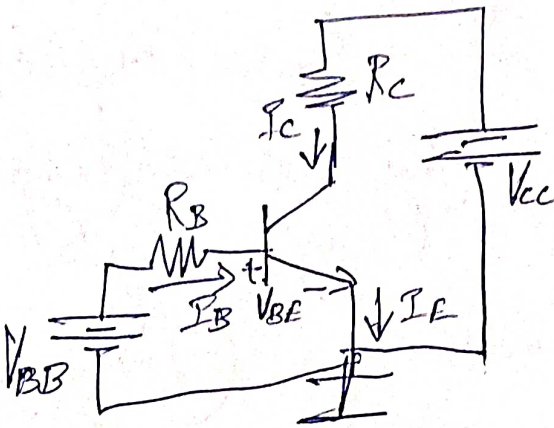
The bipolar junction transistor (BJT) has three separately doped regions and contains two pn-junctions. A single pn-junction has two modes of operation. The bipolar transistor, with two pn-junctions has four possible mode of operation, depending on the bias condition of each pn-junction, which is one reason for the versatality of the device. With three separately doped regions, the bipolar transistor is a three terminal device. The basic transistor principle is that the voltage between two terminals controls the current through the third terminal.

The npn bipolar transistor contains a thin p-region between two n-regions. In contrast, the pnp transistor contains a n-region sandwiched between two p-regions. The three regions and their terminal connections are called the emitter, base and collector. The operation of the device depends on the two pn-junctions being in close proximity, so the width of the base must be very narrow normally in less of micrometer.









The four possible ~~bias condition~~ regions of BJT are

EB - Forward Biased; CB - Reverse biased } for analog
- Forward Active operating mode

EB - FB; CB - FB - Saturation Region } for digital
EB - RB; CB - RB - Cut-off Region
EB - Reverse Biased; CB - Forward biased - Reverse active region - NOT so useful

Current Relationships:- If we treat the bipolar transistor as a single node, then by Kirchhoff's current law, we have

$$i_E = i_C + i_B$$

If the transistor is biased in forward active mode $i_C = \beta i_B$

We can ~~be~~ put Eq (2) in Eq. (1) to obtain

$$i_E = (1+\beta) i_B$$

By rearranging the above equations we get

$$i_C = \left(\frac{\beta}{1+\beta}\right) i_E = \alpha i_E$$

where $\alpha = \frac{\beta}{1+\beta}$

$$\beta = \frac{\alpha}{1-\alpha}$$

Objective: Calculate the collector and emitter currents, given the base current and current gain ($\beta = 150$). Find α.

$i_B = 15\mu A$

$$i_C = \beta i_B = 2.25mA$$

$$i_E = (1+\beta) i_B = 2.27mA$$

$$\alpha = \frac{\beta}{1+\beta} = \frac{150}{151} = 0.9934$$

In summary, the novel GSO algorithm presented in this thesis should find numerous practical applications where multimodal and multidimensional cost functions are involved. The presented algorithm is population based and hence will lend naturally for extension to multi-objective optimization methodologies.

Common-Emitter Circuit

One of the basic transistor circuit configurations is called the common-emitter circuit. The figure below shows the example of common emitter circuit:

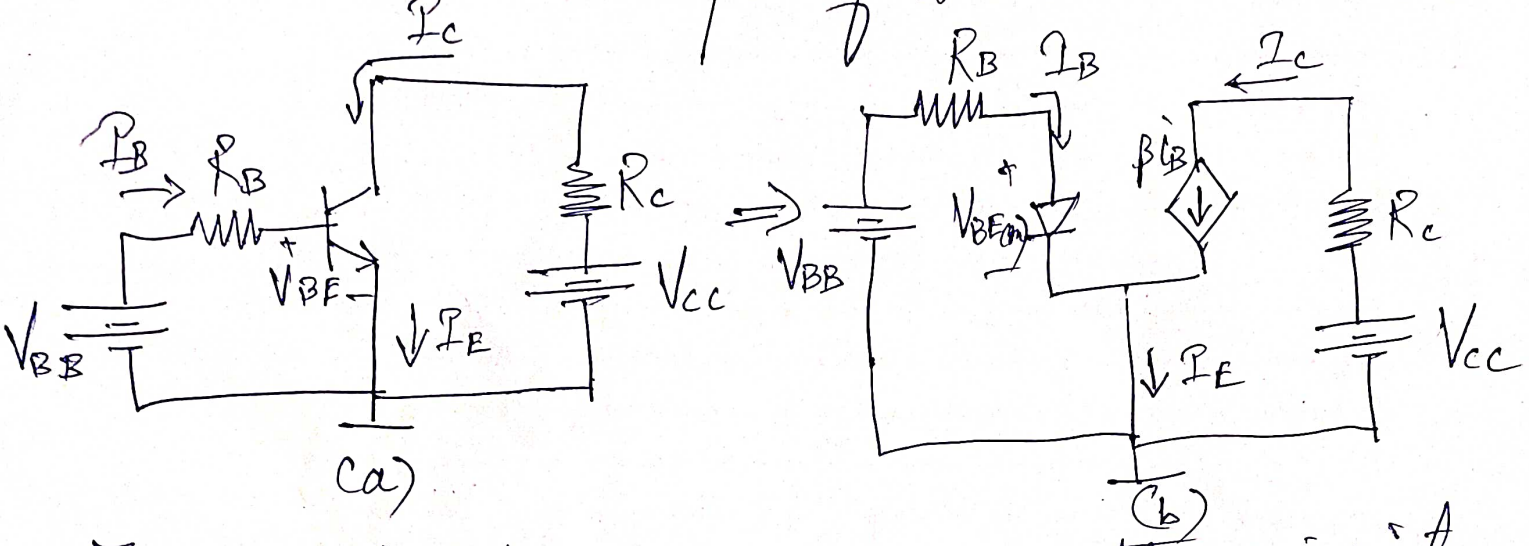


Figure (a) shows a common emitter circuit with an npn transistor and Fig (b) shows the dc equivalent circuit. We will assume that the B-E junction is forward biased, so that the voltage drop across that junction is is the cut-in or turn-on voltage $V_{BE(on)}$. When the transistor is biased in the forward-active mode, the collector current is represented as a dependent current source that is a function of the base current.

$$I_B = \frac{V_{BB} - V_{BE(on)}}{R_B}$$

We implicitly assume that $V_{BB} > V_{BE(on)}$ which means $I_B > 0$. When $V_{BB} < V_{BE(on)}$ the transistor is cut-off and $I_B = 0$.

In the collector-emitter portion of the circuit, we can write

$$I_C = \beta I_B$$

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

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

We also assume that $V_{CE} > V_{BE(on)}$, which means that the B-C junction is reverse biased and the transistor is biased in the forward active mode.

The power dissipated in the transistor is given by $P_T = I_B V_{BE(on)} + I_C V_{CE}$

In most cases $I_C >> I_B$ and $V_{CE} >> V_{BE(on)}$ so that a good first approximation of the power dissipated is given as

$$P_T \cong I_C V_{CE}$$