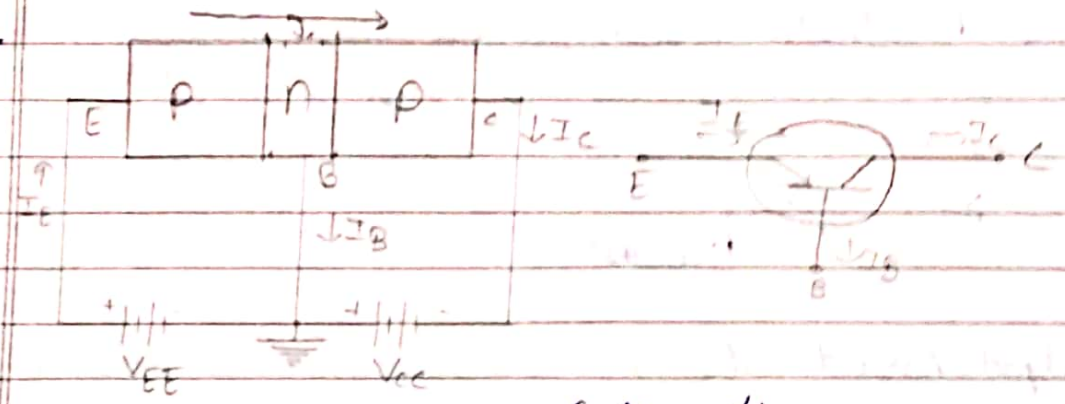
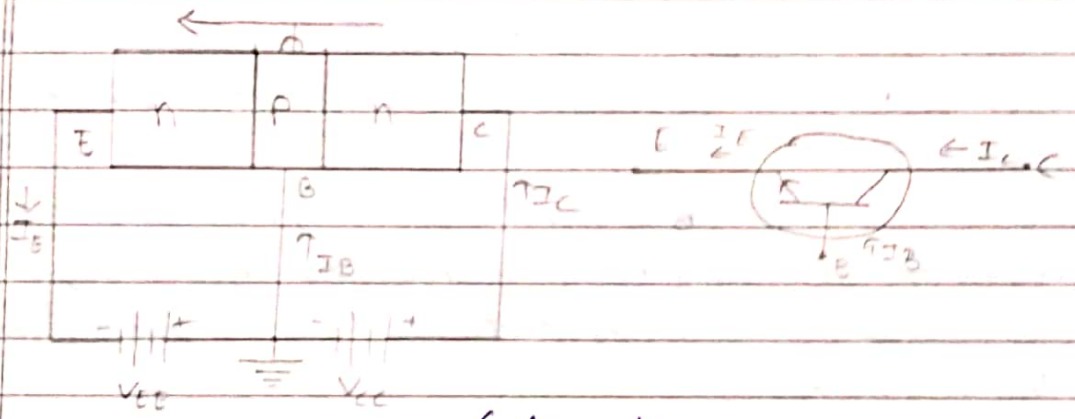
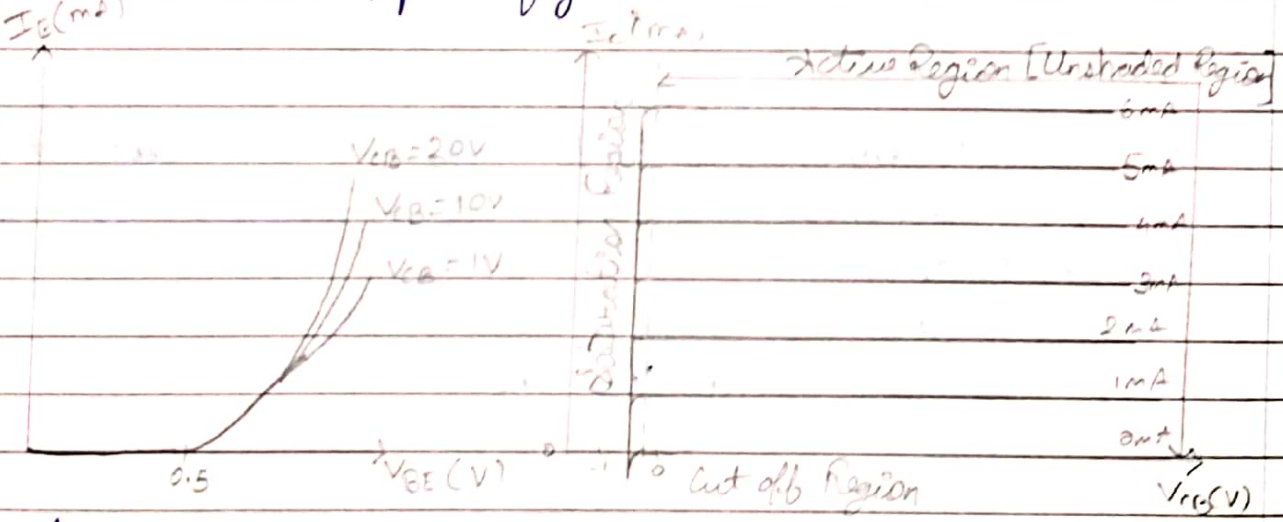
Q1.




pnp Configeration




npn Configeration




Input Charac.

Output Charac.

Input Characteristic: It is the ratio of change in emitter-base voltage [$\Delta V_{EB}$] to the resulting change in emitter current [$\Delta I_E$] at constant collector-base voltage [$V_{CB}$]

$$\gamma_i = \left.\frac{\Delta V_{BE}}{\Delta I_E}\right|_{V_{CB}=\text{const.}}$$

Output Characteristic: It is the curve between collector to base voltage [$V_{CB}$] and collector current [$\Delta I_C$]. From the plot few points can be noted

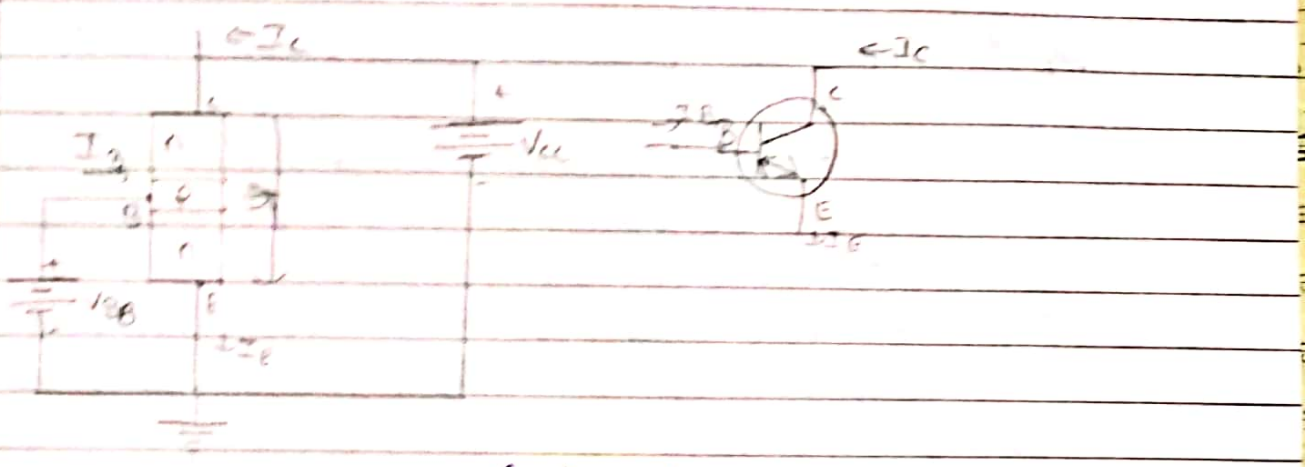
- Current $I_C$ varies with $V_{CB}$ at only few voltages [knee voltage] and the transistor is never operated in this region
- When the value of $V_{CB}$ is raised above 1-2 V, the collector current becomes ~~constant~~ constant which is indicated as a straight line in graph which means that now $I_C$ is independent on $V_{CB}$ and depends upon $I_E$ only.

$$\gamma_o = \left.\frac{\Delta V_{CB}}{\Delta I_C}\right|_{I_E=\text{const.}}$$

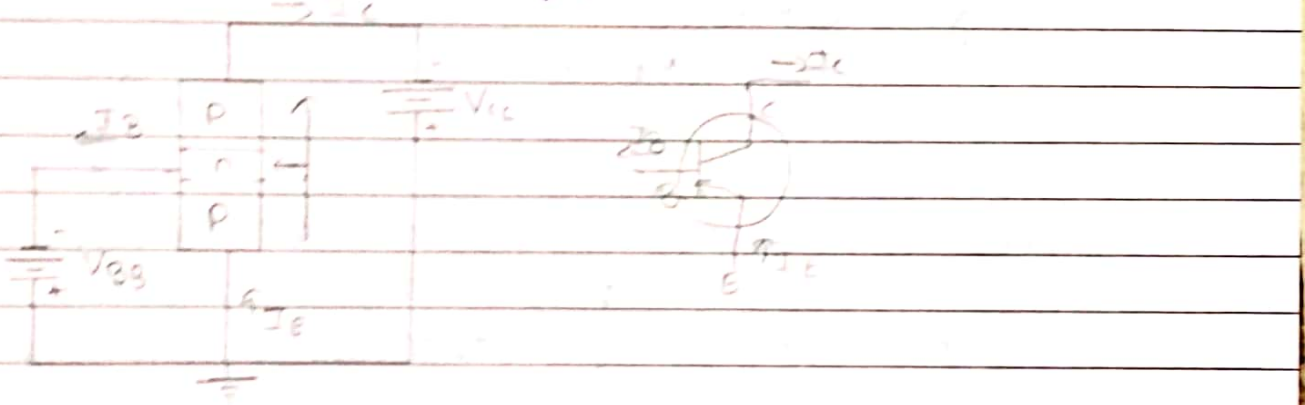
Current Amplification [$\alpha$]: Change in collector current to the change in emitter current keeping collector base voltage constant.

$$\alpha = \left.\frac{\Delta I_C}{\Delta I_E}\right|_{V_{CB}=\text{const.}}$$

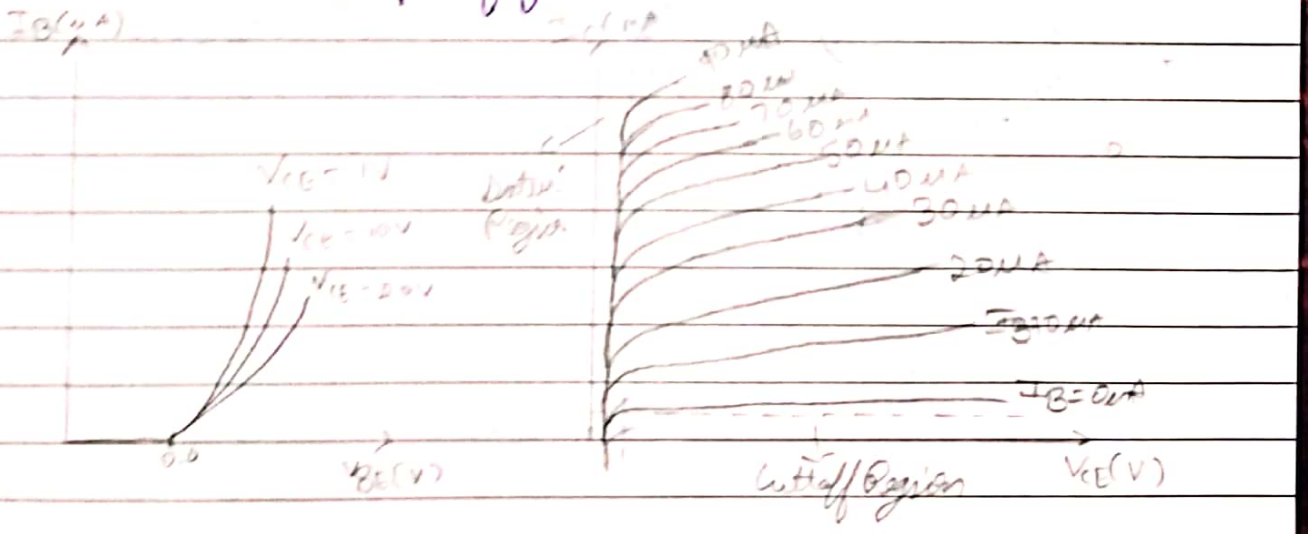
Q2.



npn Configuration



pnp Configuration



Input Characteristic: Following points can be noted from the graph:-

- The characteristic resembles that of a forward bias diode curve. This is expected since the BE section of transistor is in forward bias
- $I_B$ increases less rapidly as with $V_{BE}$ as compared to CB configuration. Therefore, input characteristic is higher in CE as compared to CB.

$$\gamma_i = \left.\frac{\Delta V_{BE}}{\Delta I_B}\right|_{V_{CE}=\text{const.}}$$

Output Characteristic: The collector current $I_C$ varies with $V_{CE}$ with between 0 to 1 V. After this the collector current almost becomes constant and independent of $V_{CE}$. This value of $V_{CE}$ upto which collector region $I_C$ changes with $V_{CE}$ is called knee voltage. The transistor is always operated above knee voltage. In this the $I_C$ is almost const.

$$I_C \simeq \beta I_B.$$

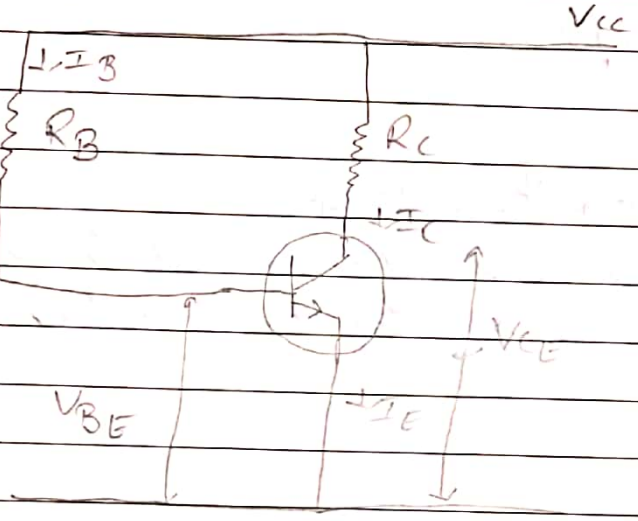
$$\beta = \frac{I_C}{I_B}$$

$$\gamma_o = \left.\frac{\Delta V_{CE}}{\Delta I_C}\right|_{I_B=\text{const.}}$$

Q3.

## Fixed Bias

In this method, a resistor $R_B$ of high resistance is connected in base, as the name implies. The required zero signal base current is provided by $V_{cc}$ which flows through $R_B$. The base emitter junction is forward bias, as base is positive with respect to emitter.




Let, $I_C$ be the required 0 signal collector current so,

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

Applying KVL

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

$$\Rightarrow I_B R_B = V_{cc} - V_{BE}$$

$$\Rightarrow R_B = \frac{V_{cc} - V_{BE}}{I_B}$$

$\because V_{BE} << V_{cc}$

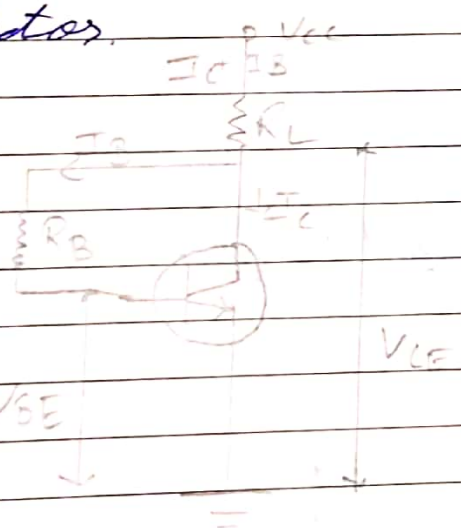
$$\therefore R_B = \frac{V_{cc}}{I_B}$$

Advantages
- Circuit is Simple
- Only one resistor $R_E$ is required
- No Load Effect

Disadvantages
- Stabilisation is poor.

## COLLECTOR-BASE BIAS

The circuit is same as fixed bias but the only difference is the base resistor $R_B$ is returned to the collector.




Voltage drop across $R_L$

$$R_L = (I_C + I_B)R_L \simeq I_C R_L \quad [\because I_B \simeq 0]$$

From Figure

$$I_C R_L + I_B R_B + V_{BE} = V_{CC}$$

$$\Rightarrow I_B R_B = V_{CC} - V_{BE} - I_C R_L$$

$$\Rightarrow R_B = \frac{V_{CC} - V_{BE} - I_C R_L}{I_B}$$

Applying KVL

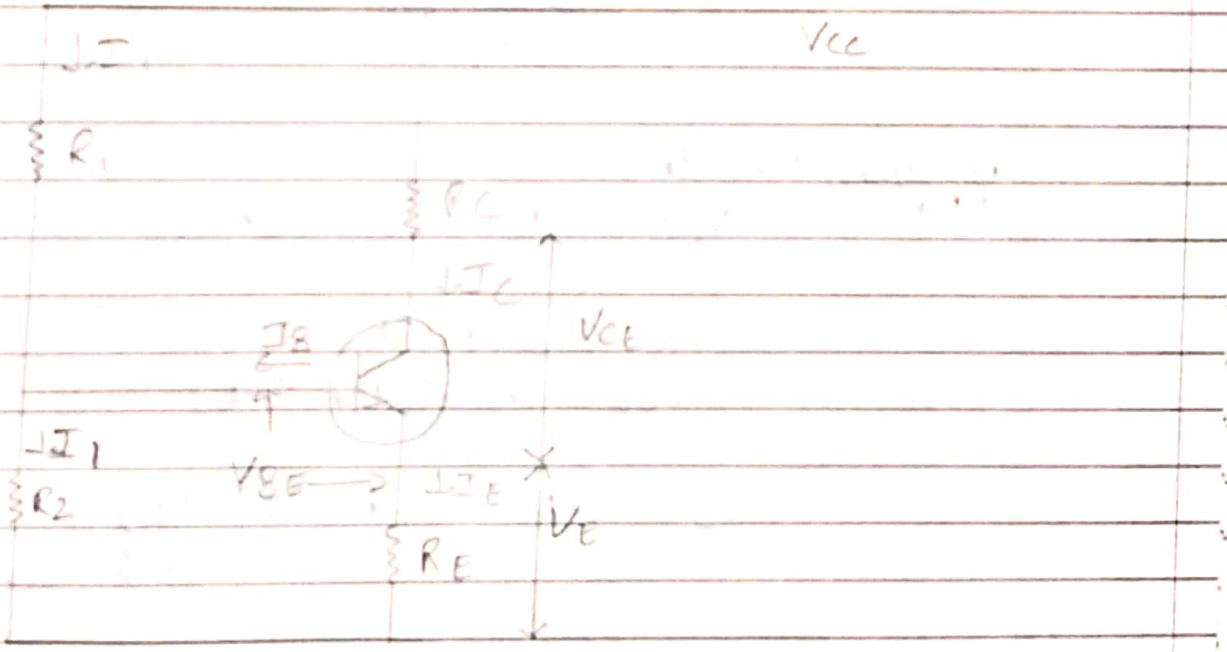
$$(I_B + I_C) R_L + I_B R_B + V_{BE} = V_{CC}$$

$$\Rightarrow I_B (R_L + R_B) + I_C R_L + V_{BE} = V_{CC}$$

$$\therefore I_B = \frac{V_{CC} - V_{BE} - I_C R_L}{R_L + R_B}$$

## POTENTIAL DIVIDER BIAS

Among all of these method, the potential devider bias is the most prominent one. Here, we use 2 resistor $R_1$ and $R_2$ which are connected to $V_{CC}$ and are providing biasing



$$I_1 = \frac{V_{CC}}{R_1 + R_2}$$

Voltage across $R_2$

$$V_2 = \left(\frac{V_{CC}}{R_1 + R_2}\right) R_2$$

Applying KVL to base circuit

$$V_2 = V_{BE} + V_E$$

$$V_2 = V_{BE} + I_E R_E$$

$$I_E = \frac{V_2 - V_{BE}}{R_E}$$

$\because I_E \simeq I_C$

$$\therefore I_C = \frac{V_2 - V_{BE}}{R_E}$$

Applying KVL to collector side

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

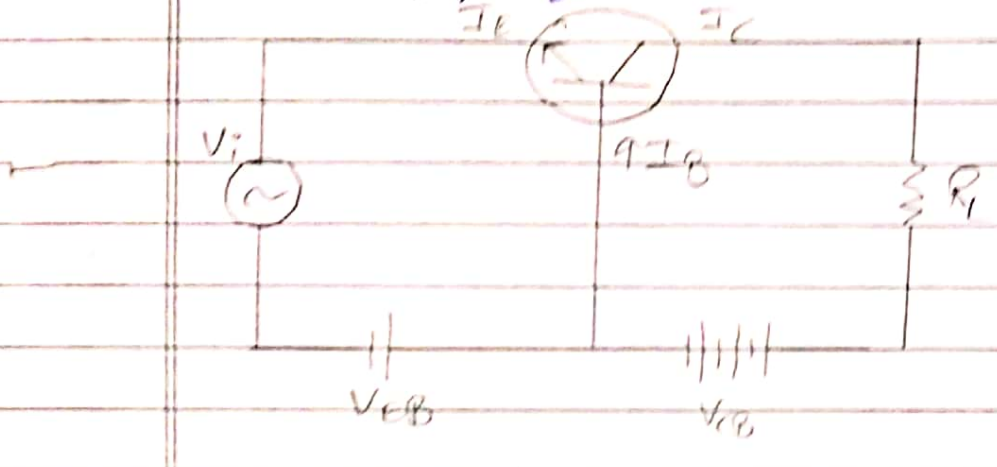
$\because I_C \simeq I_E$

$$\therefore V_{CC} = I_C (R_C + R_E) + V_{CE}$$

$$\therefore V_{CE} = V_{CC} - I_C (R_C + R_E)$$

$$V_2 = V_{BE} + I_C R_C \quad [\because R_E \text{ provides best stabilisation}]$$

Q4. A transistor acts as an amplifier by raising the strength of a weak signal. The dc bias voltage applied to the emitter base junction makes it remain in forward bias condition. This forward bias is maintained regardless of the polarity of signal.




Input Resistance

$$R_i = \frac{\Delta V_{BE}}{\Delta I_B}$$

Output Resistance

$$R_o = \frac{\Delta V_{CE}}{\Delta I_C}$$

Current Gain

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

Voltage Gain

$$A_V = \frac{\Delta V_{CE}}{\Delta V_{BE}} = \frac{\Delta I_C \times R_{CE}}{\Delta I_B \times R_i} = \beta \times \frac{R_L}{R_i}$$

$R_L$ = load Resistance.