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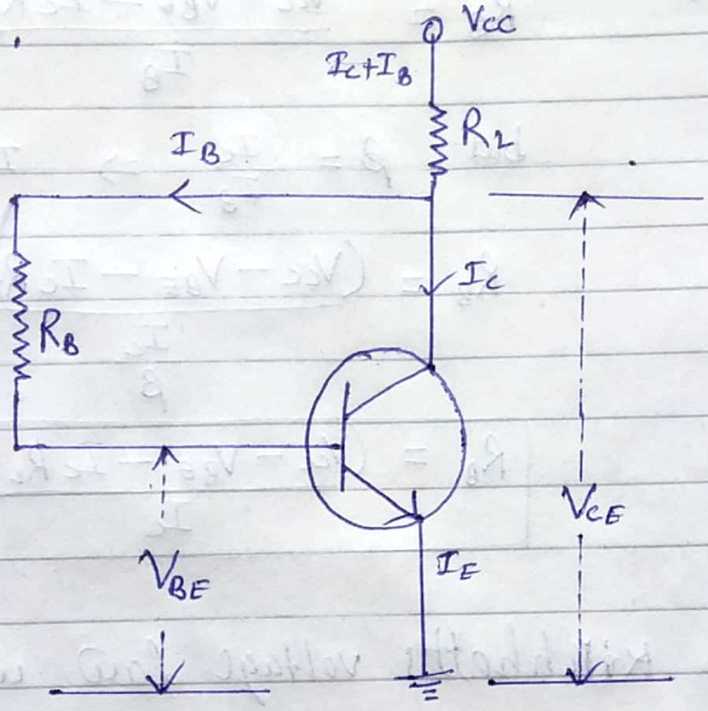
B. Sc. Part-2, Physics (Hons), Paper-IV.

Lecture-No-36

Collector to Base Bias method :-

The collector to base bias method circuit is same base bias circuit except that the base resistor R_B is returned to collector, rather than to V_{cc} supply.



This circuit helps in improving the stability considerably. If the value of I_c increases, the voltage across R_L increases and hence the V_{CE} also increases. This in turn reduces the base current I_B. This action somewhat compensates the original increase.

The required value of R_B needed to give the zero signal collector current I_c can be calculated.

voltage drop across R_L is

$$V_L = (I_c + I_B) R_L$$

$$V_L = I_c R_L + I_B R_L \simeq I_c R_L$$

From the figure,

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

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

Therefore,

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

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

$$R_B = \frac{(V_{CC} - V_{BE} - I_C R_L)}{\frac{I_C}{\beta}}$$

$$\boxed{R_B = \frac{(V_{CC} - V_{BE} - I_C R_L)\beta}{I_C}}$$

Applying Kirchhoff's voltage law we have

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

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

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

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

Since V_{BE} is almost independent of collector current, we get

$$\frac{dI_B}{dI_C} = -\frac{R_L}{R_L + R_B}$$

we know that the stability factor is given as

$$S = \frac{1+\beta}{1-\beta\left(\frac{dI_B}{dI_C}\right)}$$

Therefore,

$$S = \frac{1+\beta}{1+\beta\left(\frac{R_L}{R_L+R_B}\right)}$$

This value is smaller than $(1+\beta)$ which is obtained for fixed bias circuit. Thus there is an improvement in the stability.
This circuit is provides a negative feedback, which reduces the gain of the amplifier. So the increased stability of the collector to base bias circuit is obtained at the cost of AC voltage gain.