OPERATING POINT

Stability of quiescent operating point:

Let us assume that the transistor is replaced by an other transistor of same type. The b_{dc} of the two transistors of same type may not be same. Therefore, if b_{dc} increases then for same I_B, output characteristic shifts upward. If b_{dc} decreases, the output characteristic shifts downward. Since I_B is maintained constant, therefore the operating point shifts from Q to Q_1 as shown in **fig. 5**. The new operating point may be completely unsatisfactory.

Therefore, to maintain operating point stable, I_B should be allowed to change so as to maintain V_{CE} & I_C constant as b_{dc} changes.

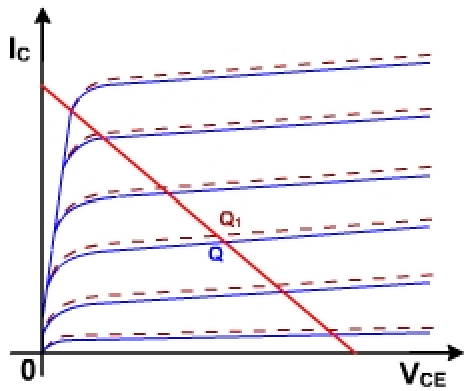

Fig. 5

A second cause for bias instability is a variation in temperature. The reverse saturation current changes with temperature. Specifically, I_{CO} doubles for every 10^oC rise in temperature. The collector current I_C causes the collector junction temperature to rise, which in turn increases I_{CO}. As a result of this growth I_{CO}, I_C will increase (b_{dc} I_B + (1+ b $_{dc}$) I_{CO}) and so on. It may be possible that this process goes on and the ratings of the transistors are exceeded. This increase in I_C changes the characteristic and hence the operating point.

Stability Factor:

The operating point can be made stable by keeping I_C and V_{CE} constant. There are two techniques to make Q point stable.

1. stabilization techniques
2. compensation techniques

In first, resistor biasing circuits are used which allow I_B to vary so as to keep I_C relatively constant with variations in b_{dc} , I_{CO} and V_{BE}.

In second, temperature sensitive devices such as diodes, transistors are used which provide compensating voltages and currents to maintain the operating point constant.

To compare different biasing circuits, stability factor S is defined as the rate of change of collector current with respect to the I_{CO}, keeping b_{dc} and V_{CE} constant

$S = I_C / I_{CO}$

If S is large, then circuit is thermally instable. S cannot be less than unity. The other stability factors are, I_C / b_{dc} and I_C / V_{BE}. The bias circuit, which provide stability with I_{CO}, also show stability even if b and V_{BE}changes.

$I_C = b_{dc} I_B + (I + b_{dc}) I_{CO}$

Differentiating with respect to I_C,

$$1 = \beta_{dc} \frac{\partial I_B}{\partial I_C} + \frac{(1+\beta_{dc})}{S}$$

$$\therefore S = \frac{1+\beta_{dc}}{1-\beta_{dc}\frac{\partial I_b}{\partial I_C}}$$

In fixed bias circuit, I_B & I_C are independent. Therefore $\frac{\partial I_B}{\partial I_C} = 0$ and S = 1 + b_{dc}. If b $_{dc}$=100, S = 101, which means $I_C$increases 101 times as fast as I_{CO}. Such a large change definitely operate the transistor in saturation.