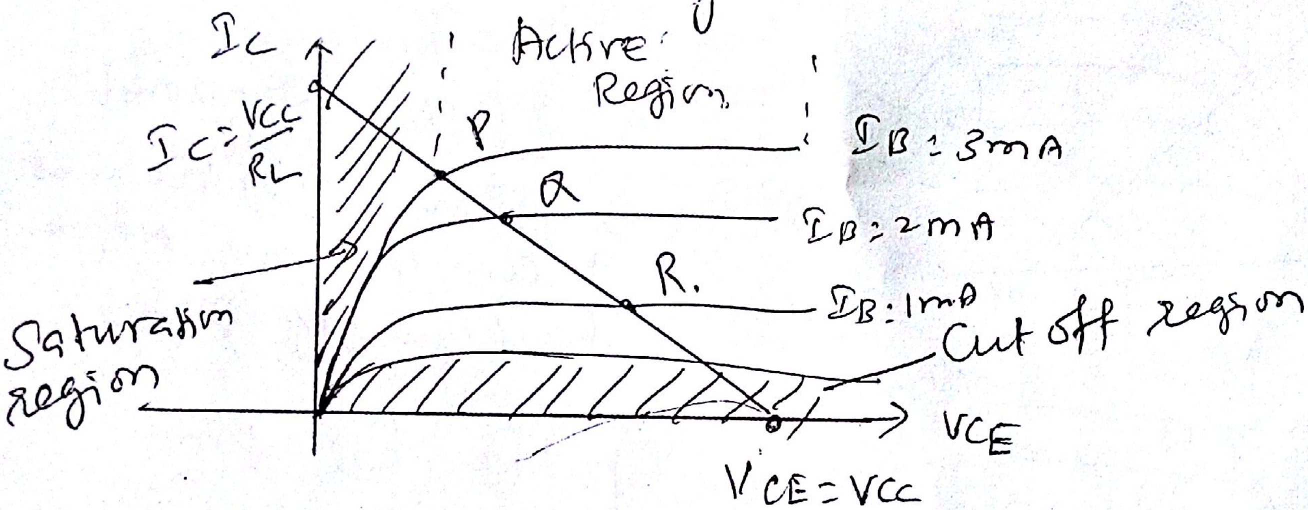
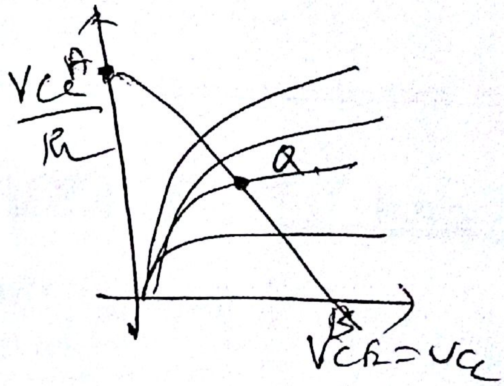
Need for Biasing

To fix the Q. point in the middle of active region, we go for biasing. The proper flow of zero signal collector current and maintenance of proper collector emitter voltage during the passage of signal is known as transistor biasing.



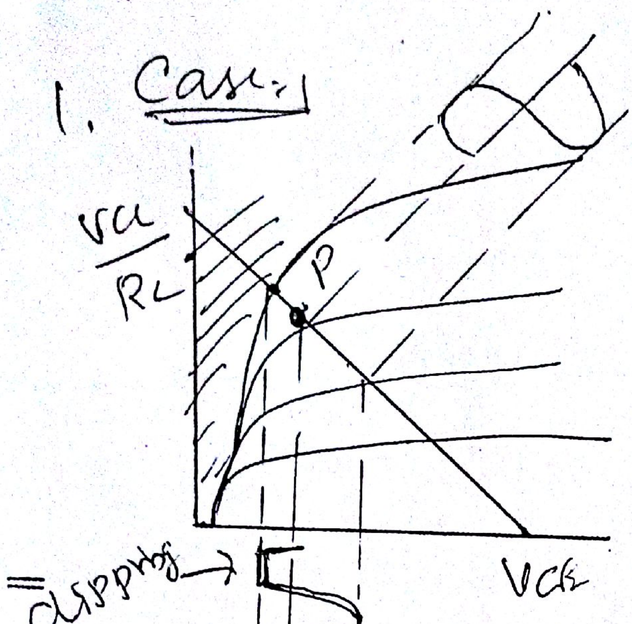
Q-point (or) Operating point (or) Quiescent point

* The zero signal values of I_C & V_{CE} are known as operating point.
* These two zero signal values are noted as 'A' & B'
* The line drawn between A and B is called DC load line
* The intercept point with DC load line is called Q point.



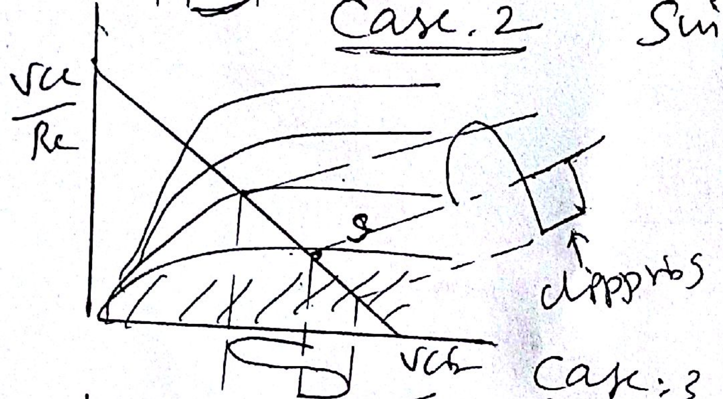
Selection of Q-point.

1. Case:-



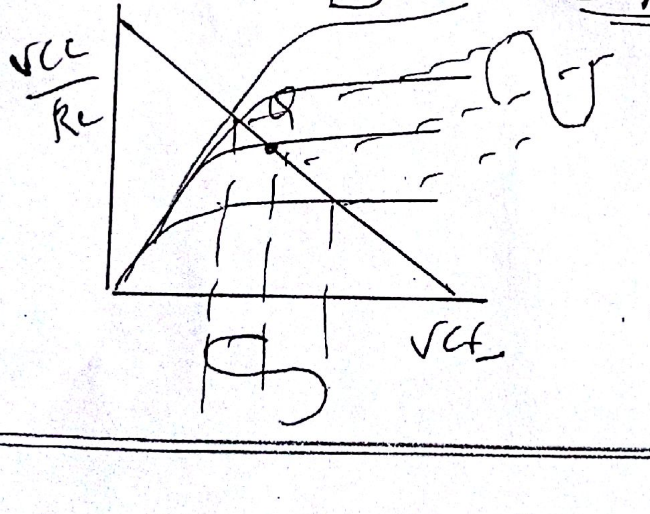
* If the Q point is placed at point 'P' very nearer to saturation
* Collector current clipping at the positive half cycle
* ∴ point 'P' is not suitable ~~for~~ operating point

Case. 2



* If the Q-point is placed (S) nearest to cut of region, Negative half cycle get clipped.

Case:-3



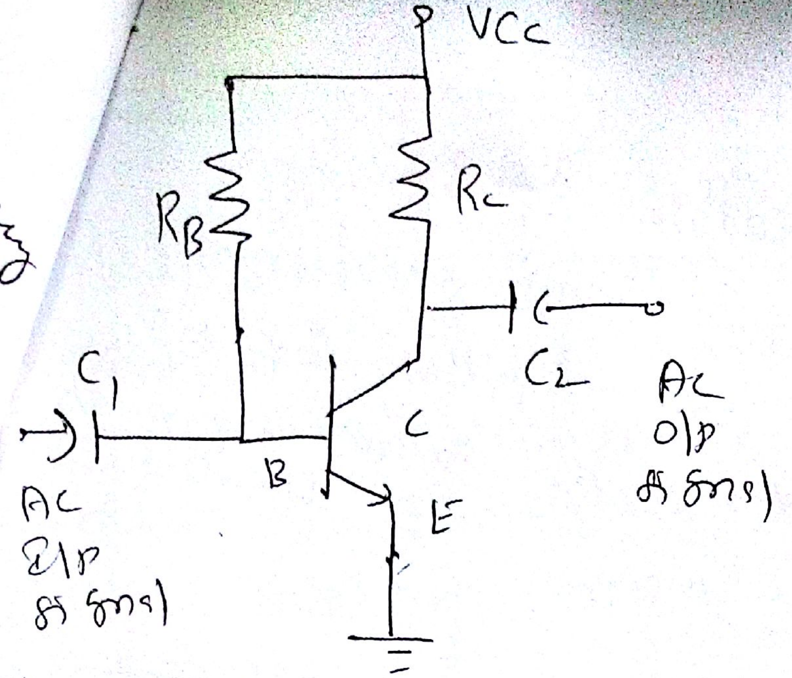
* If the Q-point is fixed at point 'Q' we get the O/P without any distortion.

Fixed Bias circuit

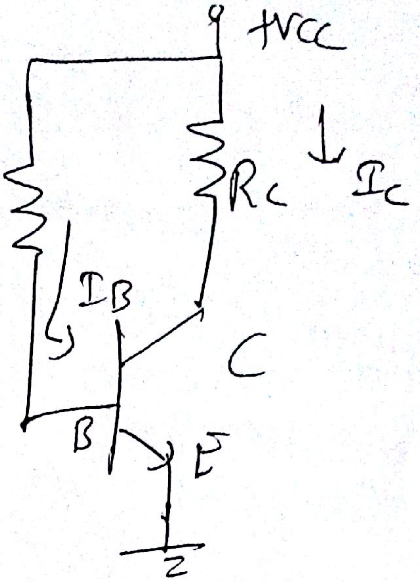
It is the simplest DC Bias configuration / compensation

DC Analysis.

Reactance of the capacitor $X_C = \frac{1}{2\pi f C}$



Fig(1) Fixed Bias circuit



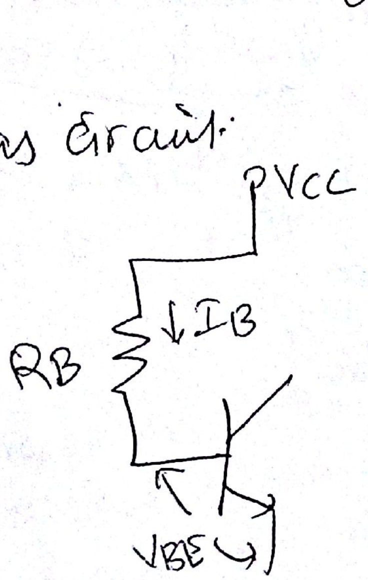
Fig(2) AC equivalent circuit

for DC: $f = 0$

$X_C = \frac{1}{0} = \infty$

We can replace capacitor with an open circuit because the reactance of the capacitor is ∞.

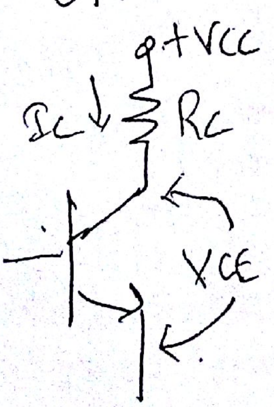
Bias circuit:



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

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

Collector circuit,



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

$$\boxed{I_C = \frac{V_{CC} - V_{CE}}{R_C}}$$

WKT $I_E = \beta I_B$

Collector current (I_C) is related to I_B by a constant of β. ~~Ex~~ I_C is not a function of R_C. changing R_C will not affect I_C & I_B as long as we remains in the active region of the device

$V_{CE} = V_C - V_E$.

$V_{BE} = V_B - V_E$.

I_{CO}: near

Variation of Q-point. (Quiescent point)

Biasing circuit should be designed to fix the Q-point at the centre of the active region. Designing the biasing circuit to stabilize the Q-point is known as **bias stability**

following factors affecting the Q-point

(1) Temperature — I_{CO}, V_{BE}, β_{dc}

(2) variation of h_{fe} (β)

Temperature

The change in temp affect the following parameters of the transistor.

1. I_{CO} (Leakage current)
2. V_{BE}
3. β_{dc}

Ico:

The flow of current in the circuit produces heat at the junctions. This heat increases the temperature at the junctions. Minority carriers are temperature dependent. Minority carrier increases due to temperature increment. The increase in the minority carriers increases the leakage current Ico.

$$\boxed{I_{CEO} = (1+\beta) I_{CBO}}$$

I_{CBO} doubles for every 10°C rise in temperature. Increase in I_{CBO} in turn increases the collector current.

$$\boxed{I_C = \beta I_B + I_{CEO}}$$

Excessive increase in I_C shift the operating point into saturation region.

The increase in collector current (I_C) increases the power dissipation at the collector junction. This in turn further increases the temperature. & hence increases the collector current. The process is cumulative. The ~~excess~~ excess heat produced at the collector base junction may burn and destroy the transistor. This situation is called Thermal Runaway of the transistor.

V_{BE}: (Base to Emitter voltage)

V_{BE} changes with temp at the rate of 2.5 mV. Base current I_B depends upon V_{BE}. I_C depends upon I_B. ∴ I_C changes with I_B due to temperature

β_{dc}: β_{dc} of the transistor is also temperature dependent. As β_{dc} varies I_C also varies. The change in collector current change the operating point.

Variation of h_{fe} (β)

No two transistors ~~are~~ have the same characteristics. There is a change in the β value in practice. The Biasing circuit is designed according to the 'β' value. Due to change in 'β', the operating point may shift.

Requirement of a Biasing Circuit

To maintain the operating point stable by keeping I_C & V_{CE} constant so that the transistor will always works in active region the following techniques are normally used.

① Stabilization Techniques.

② Compensation Techniques.

Stabilizin

Stabilization Technique.

It refers to the use of resistive Biasing circuits which allow I_B to vary so as to keep I_C relatively constant with variations in I_{CO}, β & V_{BE}

Compensation Techniques.

It refers to the use of temperature sensitive devices such as diodes, transistors, termistors etc. which provides compensating voltage and current to maintain the operating point stable

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Stability factor.

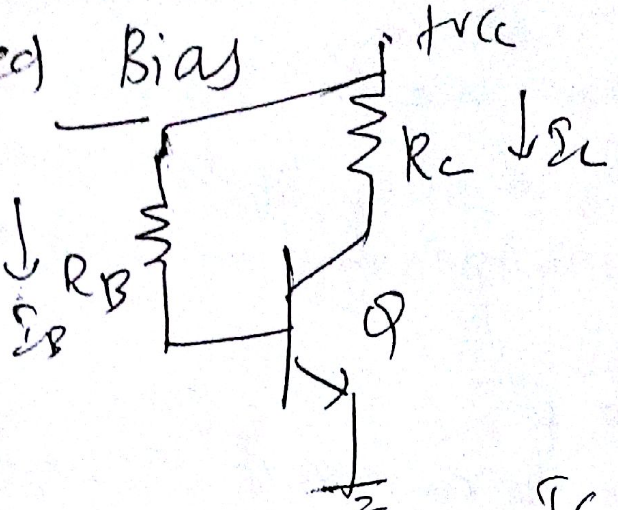
Degree of change in operating point due to variation in temperature is called stability factor

1) $$S = \left.\frac{\partial I_C}{\partial I_{CO}}\right|_{V_{BE}, \beta}$$

2) $$S' = \left.\frac{\partial I_C}{\partial V_{BE}}\right|_{I_C, \beta}$$

3) $$S'' = \left.\frac{\partial I_C}{\partial \beta}\right|_{I_{CO}, V_{BE}}$$

Fixed Bias



Stability factor : S

$I_C \doteq \beta I_B + I_{CBO}$

$I_C = \beta I_B + (1+\beta) \cdot I_{CBO}$

$\partial I_C = \beta \partial I_B + (1+\beta) \cdot \partial I_{CBO}$

$1 = \beta \cdot \frac{\partial I_B}{\partial I_C} + (1+\beta) \cdot \frac{\partial I_{CBO}}{\partial I_C}$

$\frac{\partial I_{CBO}}{\partial I_C} = \frac{1 - \beta \frac{\partial I_B}{\partial I_C}}{1+\beta}$

$\therefore$ ~~β~~ $S = \frac{\partial I_C}{\partial I_{CBO}}$

$\therefore \boxed{S = \frac{1+\beta}{1 - \beta \cdot \frac{\partial I_B}{\partial I_C}}}$

(For the fixed Bias V_{BE} & β are constant)

$I_B = \frac{V_{CC} - V_{BE}}{R_B} = \frac{V_{CC}}{R_B}$ [V_{BE} too small]

$\partial I_B / \partial I_C = 0$

$$S = \frac{\cancel{\partial a}\ 1+\beta}{1-0} = 1+\beta$$

$$\boxed{S = 1+\beta}$$

Stability factor S'

$$S' = \left.\frac{\partial I_C}{\partial V_{BE}}\right|_{I_{CO},\beta}$$

WKT

$$I_C = \beta I_B + (1+\beta) \cdot I_{CBO}$$

$$I_C = \beta \frac{(V_{CC} - V_{BE})}{R_B} + (1+\beta) \cdot I_{CBO}$$

$$\frac{\partial I_C}{\partial V_{BE}} = \frac{\beta V_{CC}}{R_B} - \frac{\beta V_{BE}}{R_B} + (1+\beta) \cdot I_{CBO}$$

$$= 0 - \beta/R_B + 0 = -\beta/R_B$$

$$\boxed{S' = -\beta/R_B}$$

~~Stability factor~~ S'' Relation between S & S'

WKT $S = 1+\beta$; $S' = -\beta/R_B$.

Multiply Nr & Dr by $(1+\beta)$

$$S' = \frac{-\beta(1+\beta)}{R_B(1+\beta)}$$

$$S' = \frac{-\beta S}{R_B(1+\beta)}$$

Stability factor S''

$$S'' = \left.\frac{\partial I_C}{\partial \beta}\right|_{V_{BE},\, I_{CO}}$$

$$I_C = \frac{\beta V_{CC}}{R_B} - \frac{\beta V_{BE}}{R_B} + (1+\beta) I_{CBO}$$

$$\frac{\partial I_C}{\partial \beta} = \frac{V_{CC}}{R_B} - \frac{V_{BE}}{R_B} + \cancel{(1+\beta)}\, I_{CBO}$$

$$\frac{\partial I_C}{\partial \beta} = I_B + I_{CBO} = \frac{I_C}{\beta}$$

$$\frac{\partial I_C}{\partial \beta} = I_C/\beta$$ since $I_B = I_C/\beta$ &

$I_B \gg I_{CBO}$

Relation between S & S''

$S = 1+\beta$; $S'' = I_C/\beta$.

$$S'' = \frac{I_C(1+\beta)}{\beta(1+\beta)}$$

$$\boxed{S'' = \frac{I_C \cdot S}{\beta(1+\beta)}}$$

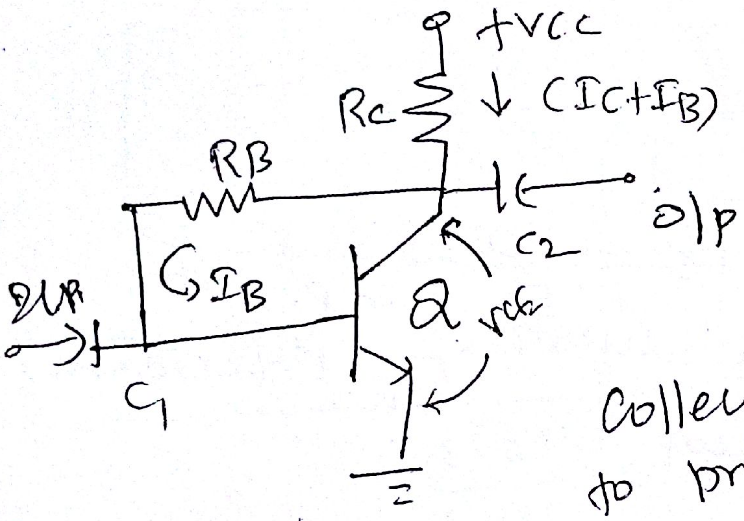
Various

1.

Various Biasing Methods

1. Fixed Bias
2. Collector to Base Bias
3. Voltage Divider / Self Bias Circuit
4. Emitter Stabilized Bias Circuit
5. Miscellaneous Bias Circuit.

Collector to Base Bias Circuit



It is an improvement over fixed bias circuit. Here biasing resistor is connected between the collector and base of the transistor to provide a feed back path through RB so $(I_C + I_B)$ flows through Rc. Thus I_B flows

Circuit Analysis

Base Circuit

$$V_{CC} = (I_C + I_B) \cdot R_C + I_B R_B + V_{BE}$$

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

$$I_B (R_C + R_B) = V_{CC} - V_{BE}.$$

$$V_{CC} = (R_B + R_C) \cdot I_B + \beta I_B \cdot R_C + V_{BE}$$

$$V_{CC} = R_B I_B + \underline{R_C I_B} + \beta \underline{I_B} R_C + V_{BE}$$

$$V_{CC} = I_B \left[(1+\beta) R_C + R_B \right] + V_{BE}$$

$$I_B = \frac{V_{CC} - V_{BE}}{R_B + (1+\beta) \cdot R_C}$$

$\because \beta >> 1$

$$\boxed{I_B = \frac{V_{CC} - V_{BE}}{R_B + \beta R_C}}$$

Collector circuit:

$$V_{CC} = (I_C + I_B) R_C + V_{CE}.$$

If collector ct I_C changes due to temp. I_C increases voltage drop across R_C increases.

$$V_{CE} = V_{CC} - (I_C + I_B) R_C$$

But V_{CC} is constant, so V_{CE} get reduced.
Due to reduction in V_{CE} I_B reduces. As I_C depends on I_B $\therefore$ I_C also reduces. In this way this circuit maintains stability.

$0 = \partial I_C R_C + \partial I_B (R_B + R_C).$

$$\partial I_B (R_B + R_C) = -\partial I_C R_C$$

$$\frac{\partial I_B}{\partial I_C} = \frac{-R_C}{R_B + R_C}$$

WKT $S = \dfrac{1+\beta}{1-\beta\left(\dfrac{\partial I_B}{\partial I_C}\right)}$

$$\boxed{S = \frac{1+\beta}{1+\beta\left(\dfrac{R_C}{R_B+R_C}\right)}}$$

It has lesses stability factor than fixed Bias

Stability factor S'

$\dfrac{\partial I_C}{\partial V_{BE}} = ?$ $\quad (I_C + I_B) R_C + I_B R_B + V_{BE}$

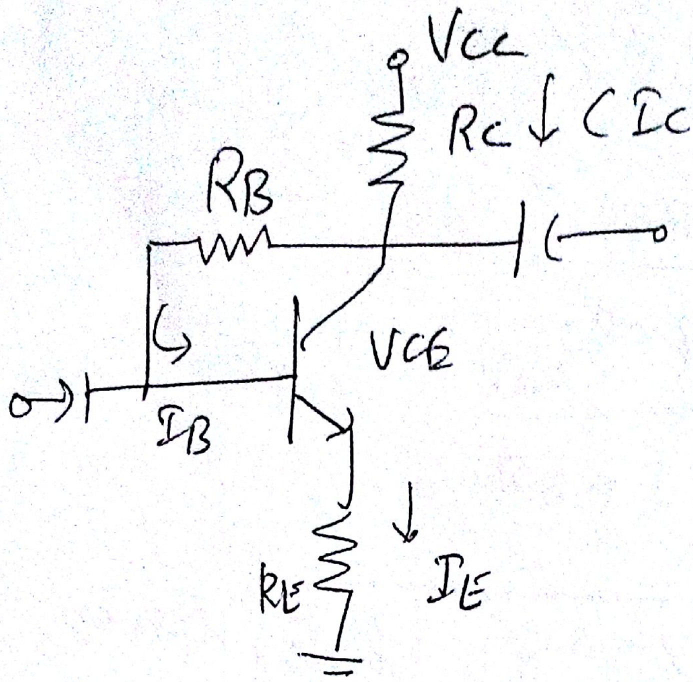
$$V_{CC} = (R_B + R_C) I_B + I_C R_C + V_{BE}$$

$$I_B = \frac{V_{CC} - V_{BE} - I_C R_C}{R_C + R_B} \qquad \left[\frac{I_C}{\beta} = I_B\right]$$

$$\frac{I_C}{\beta} + \frac{I_C R_C}{R_C + R_B} = \frac{V_{CC} - V_{BE}}{R_C + R_B}$$

$$I_C\left[\frac{1}{\beta} + \frac{R_C}{R_C + R_B}\right] = \frac{V_{CC} - V_{BE}}{R_C + R_B}$$

Modified Collector to Base Bias circuit



* To further impro... the level of stability, th... emitter resistance is connected in this circuit.

Base circuit

$$V_{CC} = (I_C + I_B) R_C + R_B I_B + V_{BE} + I_E R_E$$

$$(R_C + R_B) I_B = V_{CC} - V_{BE} - I_E R_E - I_C R_C$$

$$I_B = \frac{V_{CC} - V_{BE} - I_E R_E - I_C R_C}{R_C + R_B}$$

Collector current

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

$$I_C = \frac{V_{CC} - V_{CE} - I_E R_E - I_B R_C}{R_C}$$

Stability factor (S)

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

V_{CC} & V_{BE} are constant.

$$I_C \left[\frac{R_C + R_B + R_C\beta}{\beta(R_C + R_B)} \right] = \frac{V_{CC} - V_{BE}}{R_C + R_B}$$

$$I_C = \frac{(V_{CC} - V_{BE}) \cdot \beta \cancel{(R_C + R_B)}}{\cancel{(R_C + R_B)}\ (R_C + R_B + \beta R_C)}$$

$$I_C = \frac{\beta\ (V_{CC} - V_{BE})}{R_B + R_C(1+\beta)}$$

$$\frac{\partial I_C}{\partial V_{BE}} = \frac{-\beta}{R_B + (1+\beta) R_C}$$

$$\boxed{S' = \frac{-\beta}{R_B + (1+\beta) R_C}}$$

<u>Stability factor S''</u>

$$S'' = \frac{\partial I_C}{\partial \beta}$$

$$\left[\frac{d}{dr}\left(\frac{u}{v}\right) = \frac{v \cdot \frac{du}{dr} - u \cdot \frac{dv}{dr}}{v^2}\right]$$

$$I_C = \frac{\beta (V_{CC} - V_{BE})}{R_B + (1+\beta) \cdot R_C}$$

$$\frac{\partial I_C}{\partial \beta} = \frac{\left[(1+\beta) R_C + R_B\right]\left[V_{CC} - V_{BE}\right] - \beta (V_{CC} - V_{BE}) R_C}{((1+\beta) R_C + R_B)^2}$$

$$= \frac{V_{CC} - V_{BE} \left[(1+\beta) \cdot R_C + R_B - \beta R_C \right]}{\left[(1+\beta) R_C + R_B \right]^2}$$

$$= \frac{(V_{CC} - V_{BE}) \, (R_C + R_B)}{\left[(1+\beta) R_C + R_B \right]^2}$$

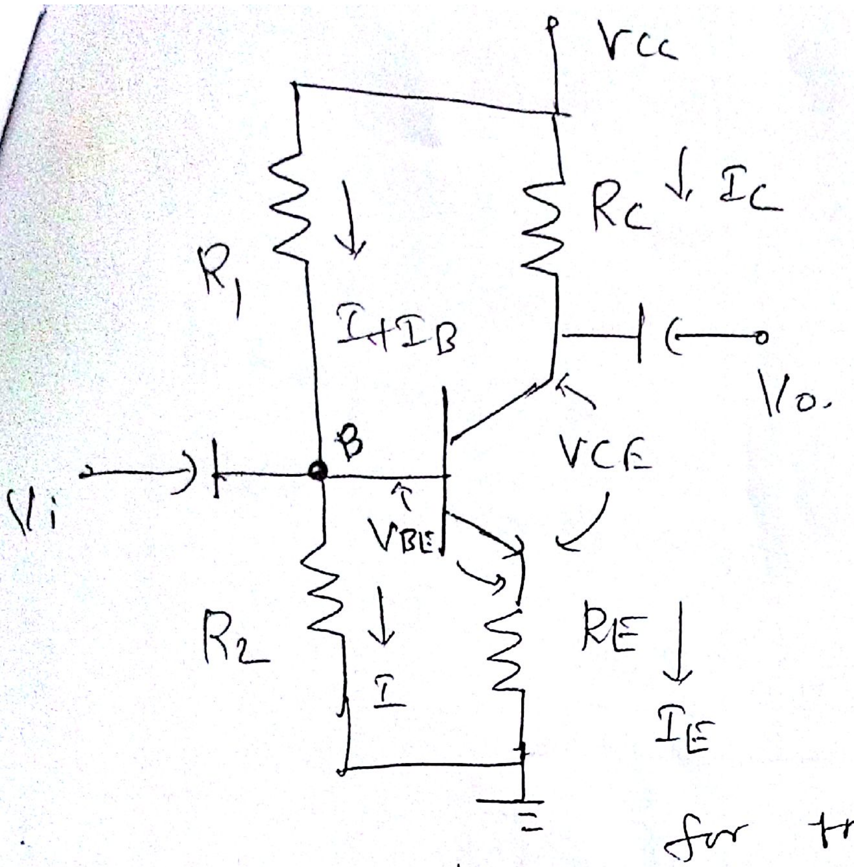
$$= \frac{(V_{CC} - V_{BE}) \, (R_C + R_B)}{\left[(1+\beta) R_C + R_B \right] \left[(1+\beta) R_C + R_B \right]}$$

$$\boxed{S'' = \frac{I_C \, (R_B + R_C)}{\beta \left[(1+\beta) R_C + R_B \right]}}$$

$$S'' = \quad \left[\because I_C = \frac{\beta (V_{CC} - V_{BE})}{(1+\beta) R_C + R_B.} \right.$$

Voltage Divider Bias [Self Bias)

Biasing is provided by three resistances R_1, R_2 & R_E. R_1 & R_2 act as a potential divider giving a fixed voltage to point B. If 'I_C' current increases due to temperature, the emitter current 'I_E' also increases. the voltage drop across R_E increases and the

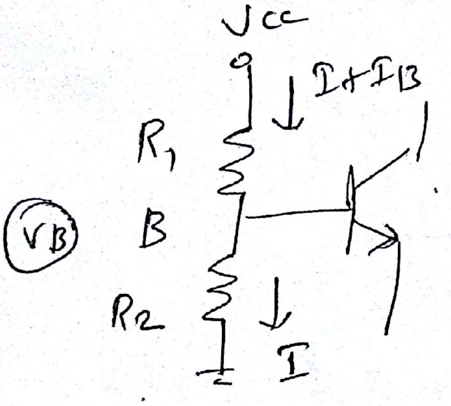


It reduces the voltage drop between base & emitter. (VBE). Due to reduction in VBE, I_B reduces. Due to I_B reduces, I_C gets reduced. This reduction in I_C compensates for the original change in I_C.

Negative feed back exists in this circuit.

Circuit Analysis

Base circuit

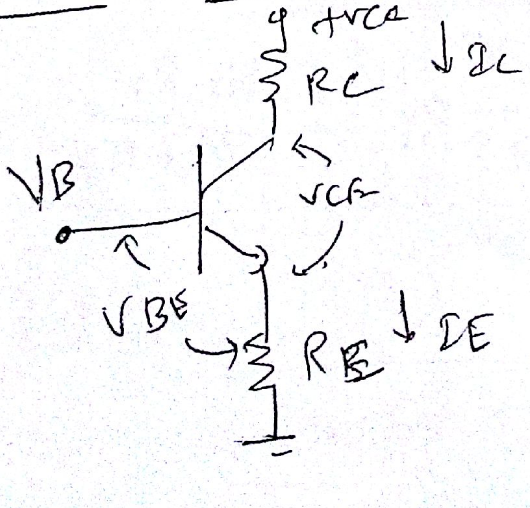


$$\boxed{V_B = \frac{R_2}{R_1+R_2} \times V_{CC}}$$

$$V_E = I_E R_E = V_B - V_{BE}$$

$$\boxed{I_E = \frac{V_B - V_{BE}}{R_E}}$$

Collector circuit

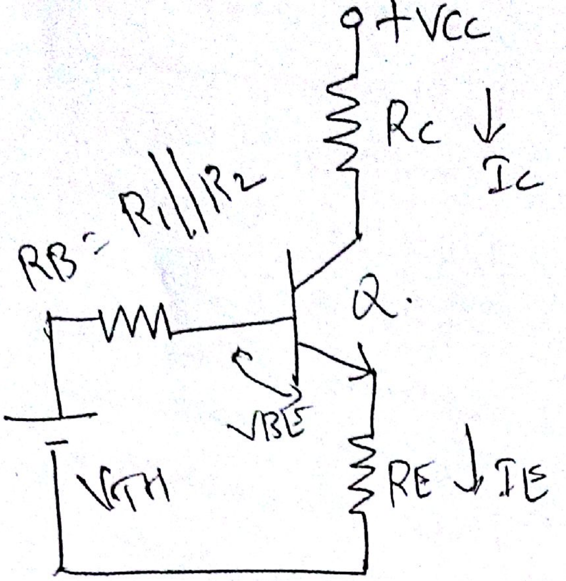


Apply KVL

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

$$\boxed{V_{CE} = V_{CC} - I_C R_C - I_E R_E}$$

Simplified Circuit of Voltage Divider Bias



R_1 and R_2 replaced by R_B.

V_{TH}.

$R_B \rightarrow$ ||el combination of R_1 & R_2

$V_{TH} \rightarrow$ Thevenin's Voltage.

$$R_B = \frac{R_1 R_2}{R_1 + R_2}$$

Apply KVL to the base circuit.

$$V_{TH} = I_B R_B + V_{BE} + I_E R_E \qquad [I_E = I_C + I_B]$$

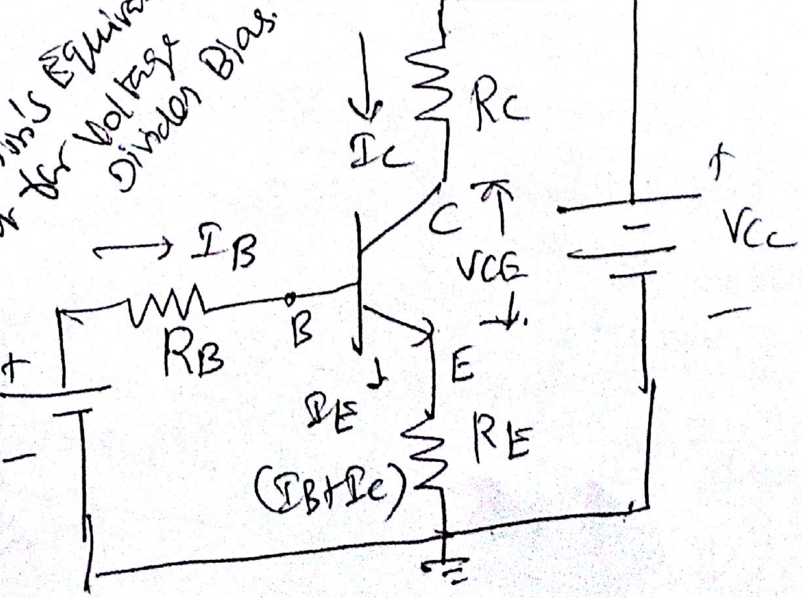
$$V_{TH} = I_B R_B + I_C R_E + I_B R_E + V_{BE}$$

$$V_{TH} = I_B (R_B + R_E) + I_C R_E + V_{BE}$$

$$V_{BE} = V_{TH} - (R_B + R_E) I_B - I_C R_E$$

Stability factor (S)

Thevenin's Equivalent circuit for voltage Divider Bias



$$V_{TH} = \frac{R_2}{R_1 + R_2} \cdot V_{CC}$$

$$R_B = \frac{R_2 R_1}{R_1 + R_2}$$

Apply KVL to the Base circuit,

$$V_{TH} = I_B R_B + V_{BE} + (I_B + I_C) \cdot R_E$$

diff w.r.to ~~V_{BE}~~ I_C

$$0 = \frac{\partial I_B}{\partial I_C} R_B + 0 + \frac{\partial I_B}{\partial I_C} \cdot R_E + R_E$$

$$\frac{\partial I_B}{\partial I_C}(R_B + R_E) = -R_E$$

$$\boxed{\frac{\partial I_B}{\partial I_C} = \frac{-R_E}{R_B + R_E}}$$

Already w.k.t

$$S = \frac{1+\beta}{1-\beta\left(\frac{\partial I_B}{\partial I_C}\right)}$$

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

$$\boxed{S = \frac{1+\beta}{1+\beta\frac{R_E}{R_B+R_E}}}$$

$$S = \frac{(1+\beta)(R_B+R_E)}{R_B+R_E+\beta R_E}$$

$$S = \frac{(1+\beta)(R_B + R_E)}{R_B + (1+\beta)R_E}$$

$\div$ Each term by R_E

$$S = \frac{(1+\beta)(1 + R_B/R_E)}{(1+\beta) + R_B/R_E}$$

From eqn, we can observe the following

Stability factor 'S'.

1. R_B/R_E controls the value of

If $R_B/R_E \ll 1$, then.

$$S = \frac{(1+\beta)}{1+\beta} = 1$$

Practically $R_B/R_E \neq 0$, But we can maintain R_B/R_E as small as possible

2. To keep R_B/R_E small, It is necessary to keep R_B small. This means that $R_1 \| R_2$ must be small. Due to small value of R_1 & R_2 it draw more current from Vcc will reduce the battery life. while designing R_1 must smaller than R_2.

3. By increasing R_E, we can improve 'S'. But if R_E increases drop

iacros
dr

across RE increases. Since Vcc is constant, drop across Rc will reduce, Ic will shift the 'Q' point. & hence there is a limit in increasing RE.

$\therefore$ S → small

RB - Reasonably small.

RE = Not very large.

4. If RB/RE is fixed; β affect the 'S' value

Stability factor S'

$$S' = \left.\frac{\partial I_C}{\partial V_{BE}}\right|_{I_{CO},\,\beta}.$$

$$I_C = (1+\beta) I_{CO} + \beta I_B.$$

$$V_{TH} = I_B R_B + V_{BE} + (I_B + I_C) \cdot R_E$$

$$V_{BE} = V_{TH} - (R_E + R_B) I_B - R_E I_C.$$

$$I_B = \frac{I_C - (1+\beta) \cdot I_{CO}}{\beta}.$$

Sub I_B in V_{BE} eqn.

$$V_{BE} = V_{TH} - (R_E + R_B)\left[\frac{I_C - (1+\beta) I_{CO}}{\beta}\right] - R_E$$

$$V_{BE} = V_{TH} - \frac{(R_E + R_B)\cdot I_C}{\beta} + \frac{(R_E + R_B)(1+\beta) I_{CO}}{\beta} - R_E I_C$$

$$V_{BE} = V_{TH} - \frac{[(1+\beta) R_E + R_B] I_C}{\beta} + \frac{(R_E + R_B)(1+\beta) I_{CO}}{\beta}$$

Diff w.r.t V_{BE} with I_{CO}

$$1 = 0 - \frac{[R_B + (1+\beta) R_E]}{\beta} \frac{\partial I_C}{\partial V_{BE}} + 0$$

$$\therefore \frac{\partial I_C}{\partial V_{BE}} = \frac{-\beta}{R_B + (1+\beta) R_E}$$

$$\boxed{S' = \frac{-\beta}{R_B + (1+\beta) R_E}}$$

Stability factor S''

$$S'' = \left.\frac{\partial I_C}{\partial \beta}\right|_{V_{BE}, I_{CO}}$$

$$V_{BE} = V_{TH} - \frac{R_B + (1+\beta) R_E}{\beta} \cdot I_C + \frac{(R_E + R_B)(1+\beta)}{\beta}$$

$$= V_{TH} - \frac{R_B + (1+\beta) R_E}{\beta} I_C + V'$$

where $V' = \left[\dfrac{(R_B + R_E)(1+\beta)}{\beta}\right] I_{co}$ (23)

$= (R_B + R_E) I_{co} \quad \because \beta >> 1$

$$I_C = \frac{\beta [V_{TH} + V' - V_{BE}]}{R_B + R_E(1+\beta)}$$

Diff & take V' independent of β, then

$$\frac{\partial I_C}{\partial \beta} = \frac{R_B + R_E(1+\beta)(V_{TH} + V' - V_{BE}) - \beta(V_{TH} + V' - V_{BE})}{[R_B + R_E(1+\beta)]^2}$$

Multiply Nr & Dr by $(1+\beta)$

$$\frac{\partial I_C}{\partial \beta} = \frac{(1+\beta)(R_B + R_E)(V_{TH} + V' - V_{BE})}{(1+\beta)[R_B + R_E(1+\beta)][R_B + R_E(1+\beta)]}$$

$$\frac{\partial I_C}{\partial \beta} = S = \frac{(1+\beta)(R_E + R_B)}{R_B + (1+\beta) R_E}$$

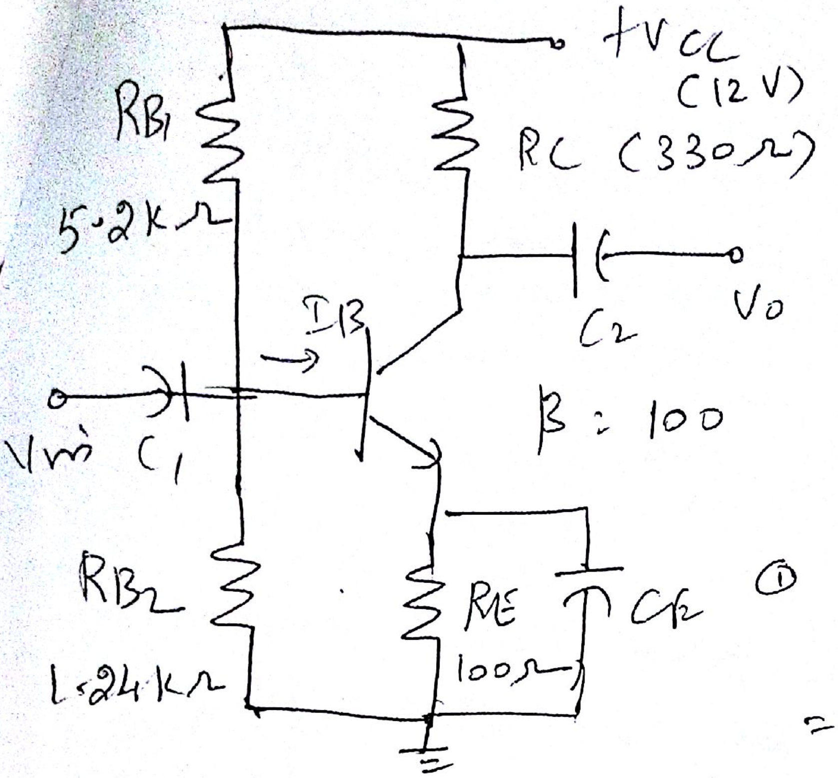
Multiply Nr & Dr by β.

$$\frac{\partial I_C}{\partial \beta} = \frac{\beta (V_{TH} + V' - V_{BE}) \cdot S}{[R_B + R_E(1+\beta)](1+\beta) \cdot \beta}$$

$$\frac{\partial I_C}{\partial \beta} = \frac{I_C \cdot S}{\beta(1+\beta)}$$

$$\boxed{S'' = \frac{I_C \cdot S}{\beta(1+\beta)}}$$

problem



Draw the DC load line for the following transistor configuration obtain the Q.point

Solution:

① $V_{TH} = \dfrac{R_{B2} \cdot V_{CC}}{R_{B1} + R_{B2}}$

$= \dfrac{1.24K \times 12}{5.2K + 1.24K} = 2.31V$

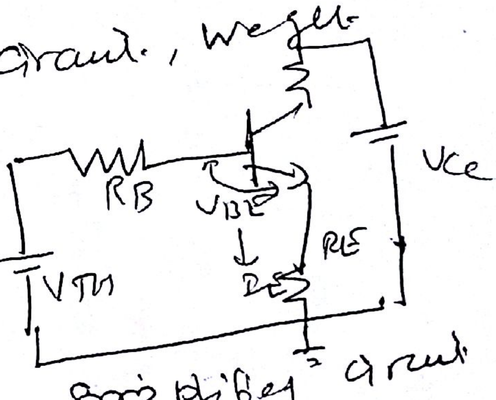
$\boxed{V_{TH} = 2.31V}$

② $R_B = R_{B1} \parallel R_{B2}$

$= 5.2K \parallel 1.24K$

$\boxed{R_B = 1K}$

Apply KVL to the base circuit, we get



simplified circuit

$I_B = \dfrac{V_{TH} - V_{BE}}{R_B + (1+\beta) R_E} = 145\,\mu A$

$[V_{TH} = I_B R_B + V_{BE} + I_E R_E$

$= I_B R_B + V_{BE} + (1+\beta) \cdot R_E]$

$I_C = \beta I_B = 100 \times 145\,\mu A = 14.5\,mA$

$\boxed{I_C = 14.5\,mA}$

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

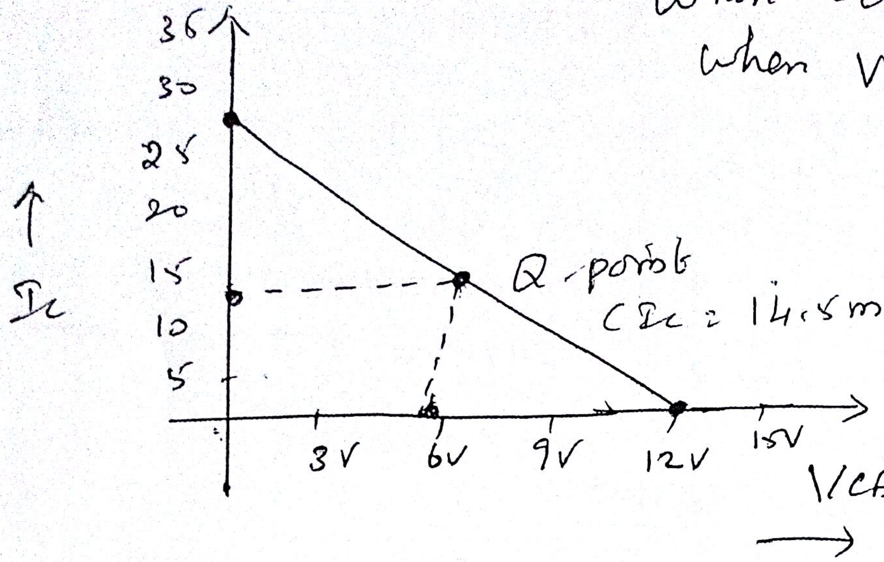
$V_{CE} = V_{CC} - I_C R_C - I_E R_E = V_{CC} - I_C R_C - (1+$

$= 12 - 14.5\,mA \times 330 - 145\,\mu A \times 100$

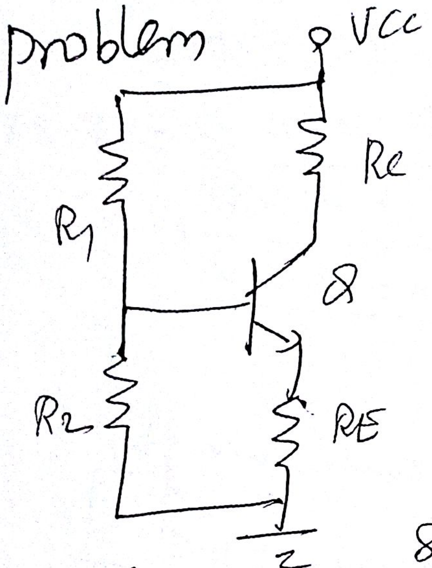
$V_{CE} = 6.7505\,V$

When $I_C = 0$; $V_{CC} = V_{CE} = 12$

when $V_{CE} = 0$ $I_C = \frac{V_C}{R_C + R_E} = 27$ mA



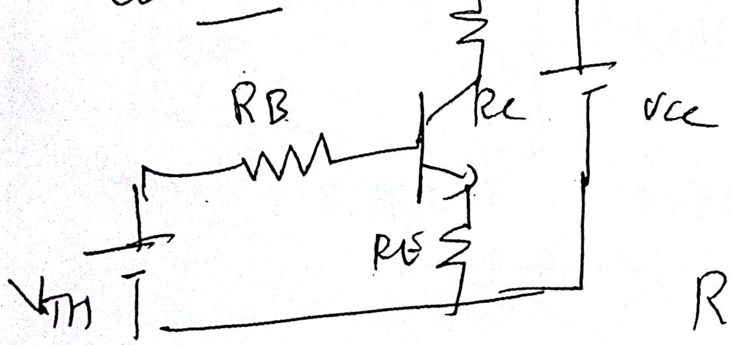
problem



For the given circuit diagram $V_{CC} = 20V$, $R_C = 2k\Omega$, $\beta = 50$, $V_{BE} = 0.2V$, $R_1 = 100k\Omega$, $R_E = 100\Omega$. Calculate I_B, V_{CE}, I_C and stability factor S.

Since R_2 is not given, assume $R_2 = 10K$

Solution:



$$V_{TH} = \frac{R_{B2} V_{CC}}{R_{B1} + R_{B2}} = \frac{20 \times 10}{100 + 10}$$

$$V_{TH} = 1.818V$$

$$R_B = R_1 || R_2 = 9.09k\Omega$$

$$I_B = \frac{V_{TH} - V_{BE}}{R_B + (1+\beta) R_E} = \frac{1.812 - 0.2}{9.09K + (1+50)100}$$

$$I_B = 114 \mu A$$

$I_C = \beta I_B = 5.7 mA$

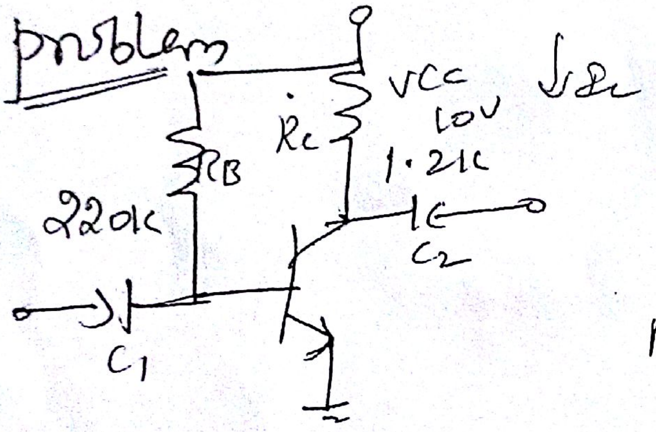
$V_{CE} = V_{CC} - I_C R_C - (1+\beta) I_B R_E$

$V_{CE} = 8V$

$$S = \frac{1+\beta}{1+\beta\left(\frac{R_E}{R_B+R_E}\right)} = \frac{1+50}{1+50\left(\frac{100}{100+9.09\times10^3}\right)}$$

$\boxed{S = 33}$

problem



For the given circuit. Calculate $I_B, I_C, V_{CE}, V_B,$ V_C & V_{BC}

Assume $V_{BE} = 0.7V$; $\beta = 50$

Solution:

$$I_B = \frac{V_{CC} - V_{BE}}{R_B} = \frac{10-0.7}{220\times10^3} = 42.27 \mu A$$

$I_C = \beta I_B = 50\times42.27\times10^{-6} = 2.1135 mA$

$V_{CE} = V_{CC} - I_C R_C = 10 - 2.1135\times10^{-3} \times 1.2\times10^{3}$

$V_{CE} = \underline{7.4638 V}$

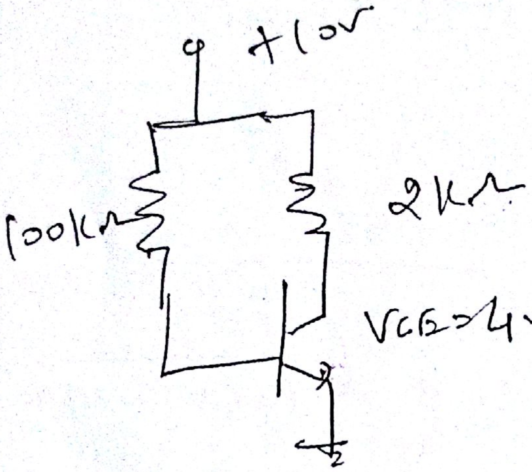
$V_B = V_{BE} = 0.7V$.

$V_C = V_{CE} = 7.463V$.

$V_{BC} = V_B - V_C = 0.7 - 7.4638$

$= -6.7638$

Pblm
For the given circuit calculate stability factor.



$S = 1+\beta$

$\beta = I_C / I_B$

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

$I_C = \frac{V_{CC} - V_{CE}}{R_C} = 3mA$

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

$I_B = \frac{V_{CC} - V_{BE}}{R_B} = 93\mu A$

$\beta = I_C / I_B = 32.258$

$\boxed{S = 1+\beta = 33.258}$