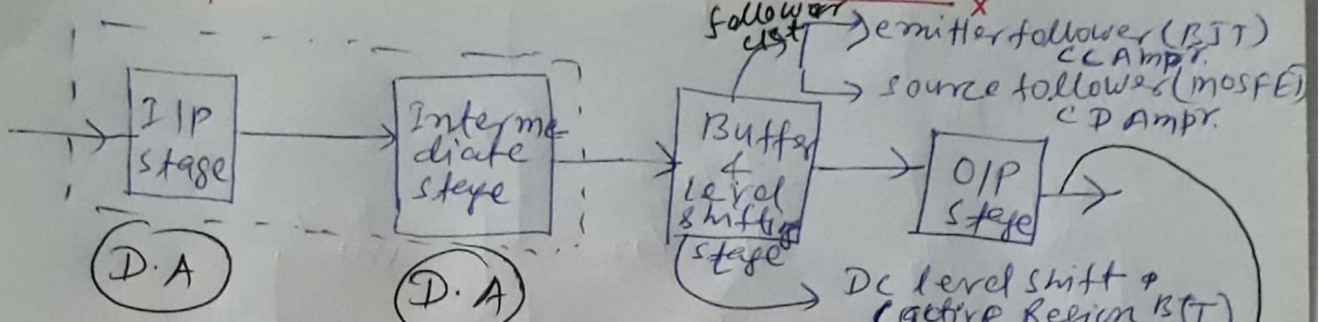
Differential Amplifier (G)



Direct coupled High gain Ampr.

fig. Block diagram of op-Ampr.

push-pull Ampr (class-B).

(i) High o/p voltage.

(ii) High current swing capability.

(iii) Low power Dissipation

(iv) Short ckt protection.

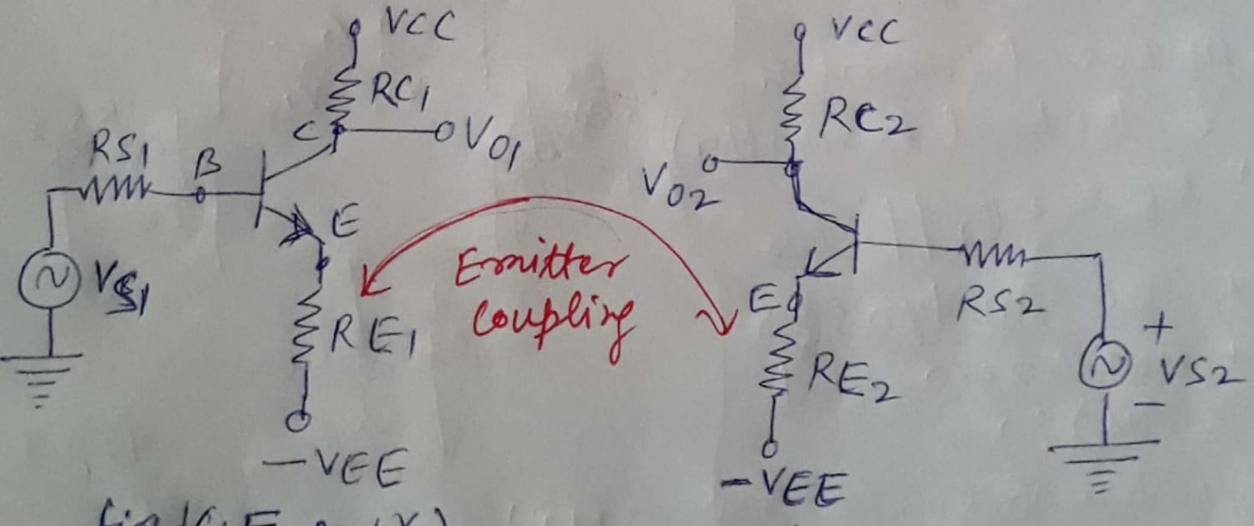
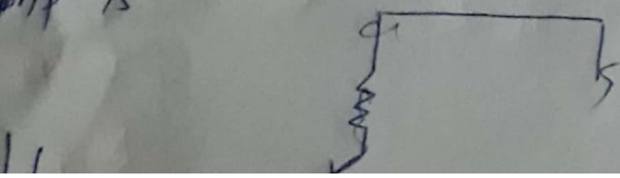


fig (C.E. Ampr)

fig C.E Ampr

After coupling of Emitter terminal, the New ckt for differential Ampr is



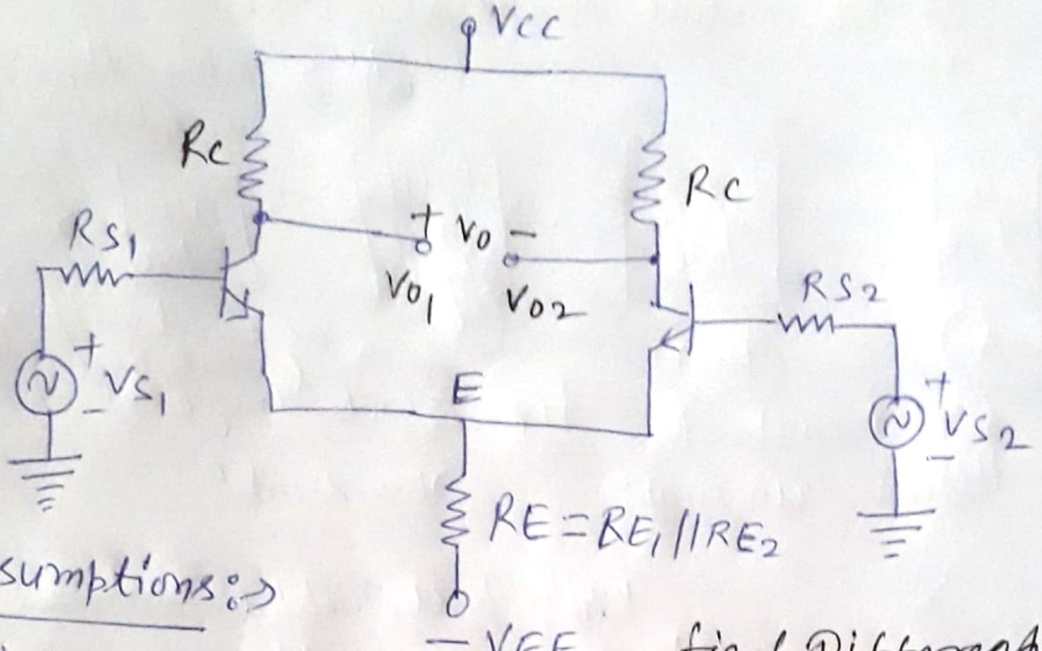


fig (Differential Ampr)

Assumptions:→

(i) $R_{C_1} = R_{C_2} = R_C$

(ii) $R_{S_1} = R_{S_2} = R_S$

(iii) $|V_{CC}| = |-V_{EE}|$

(iv) $\beta_1 = \beta_2 = \beta$

(v) Matched transistor (identical transistor)

(vi) $R_E = R_{E_1} || R_{E_2}$

Now, DC Analysis:→ (that means zero signal Analysis):→

Calculation of Differential Ampr:- fig ①

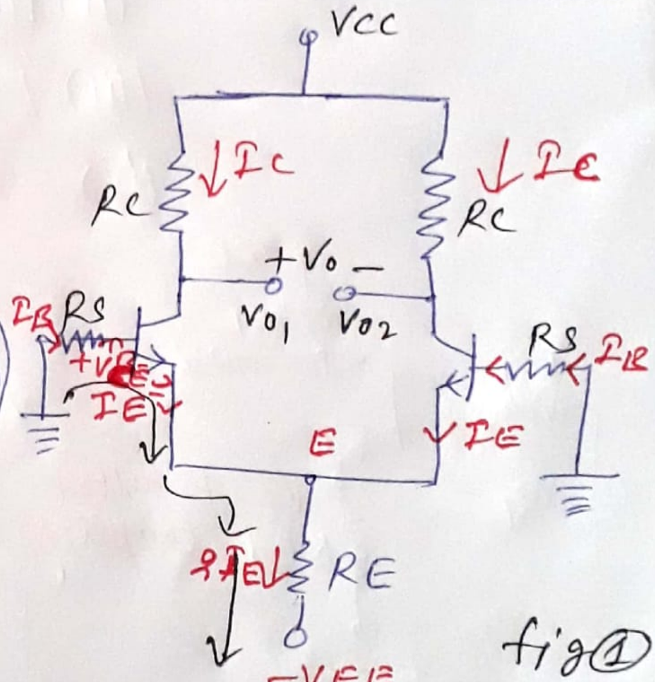


fig ①

In transistor have two operating points.

(i) ICQ → collector current Q point

(ii) VCEQ.

operating point.

Now, Apply KVL,

$I_B R_S + V_{BE} + 2R_E I_E - V_{EE} = 0$ —①

$I_B + I_C = I_E$

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

$I_B + \beta I_B = I_E$

$(1+\beta) I_B = I_E$

Now, change eqn ①, then

$I_B R_S + V_{BE} + 2 R_E I_E - V_{EE} = 0$

$I_B R_S + V_{BE} + 2 R_E I_B (1+\beta) - V_{EE} = 0$

$I_B [R_S + 2 R_E (1+\beta)] = V_{EE} - V_{BE}$

$\frac{I_C}{\beta} \{ R_S + 2 R_E (1+\beta) \} = V_{EE} - V_{BE}$ $\left[\because I_B = \frac{I_C}{\beta} \right.$

$$I_C = \frac{V_{EE} - V_{BE}}{\frac{R_S}{\beta} + \frac{2 R_E (1+\beta)}{\beta}}$$

← ① operating point of transistor.

or

$$I_{CQ} = \frac{V_{EE} - V_{BE}}{\frac{R_S}{\beta} + 2 R_E}$$

if suppose,

$\frac{R_S}{\beta} << 2 R_E$, then

or

$R_S = 0$

$$\therefore I_{CQ} = \frac{V_{EE} - V_{BE}}{2 R_E}$$

* if given,

$V_{CC} = 10V$

$-V_{EE} = -10V$

$V_{BE} = 0.7V$

$R_E = 1 k\Omega$

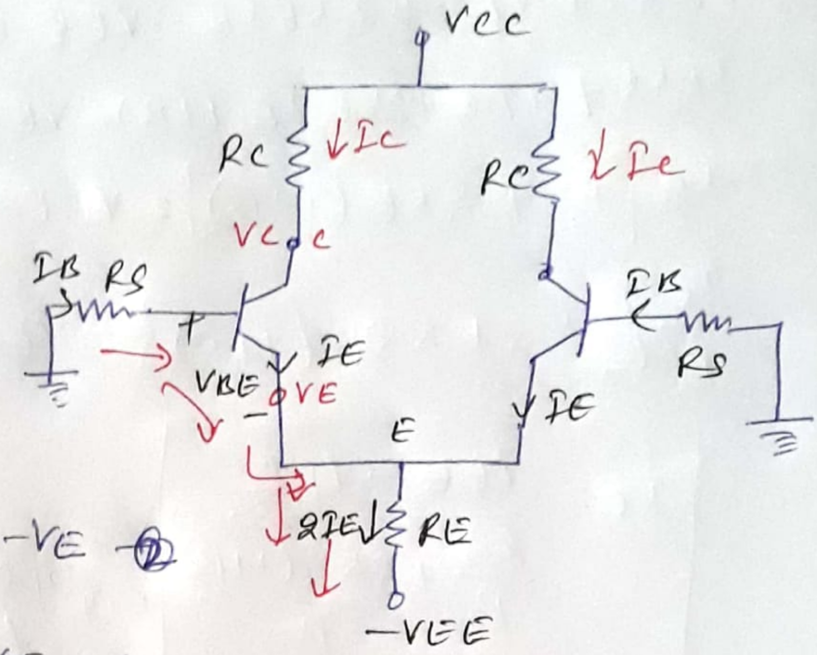
$\therefore I_{CQ} = \frac{10 - 0.7}{2 \times 1}$

$= \frac{9.3}{2}$

$I_{CQ} = 4.65 \, mA$ Ans

DC Analysis or zero signal analysis:-

(ii) Apply KVL,



$V_{CQ} = V_{CE} = V_C - V_E$

$V_{CC} = I_e R_C + V_C$ — (1)

$V_C = V_{CC} - I_e R_C$

$V_{CE} = V_{CC} - I_C R_C - V_E$ — (2)

$I_B R_S + V_{BE} + V_E = 0$

$I_B R_S < V_{BE}$

$I_B R_S < 0.7\,V$

$V_{BE} + V_E = 0$

$\boxed{V_E = -V_{BE}}$

$\therefore \boxed{V_{CE} = V_{CC} - I_C R_C + V_{BE}}$

V_{CQ}. point

2nd operating point

Now, change eqⁿ ①, then

$$I_B R_S + V_{BE} + 2R_E I_E - V_{EE} = 0$$

$$I_B R_S + V_{BE} + 2R_E I_B(1+\beta) - V_{EE} = 0$$

$$I_B [R_S + 2R_E(1+\beta)] = V_{EE} - V_{BE}$$

$$\frac{I_C}{\beta} [R_S + 2R_E(1+\beta)] = V_{EE} - V_{BE} \quad \left(\because I_B = \frac{I_C}{\beta}\right)$$

$$\boxed{I_C = \frac{V_{EE} - V_{BE}}{\frac{R_S}{\beta} + \frac{2R_E(1+\beta)}{\beta}}}$$

← ① operating point of transistor.

or

$$\boxed{I_{CQ} = \frac{V_{EE} - V_{BE}}{\frac{R_S}{\beta} + 2R_E}}$$

if suppose,

$\frac{R_S}{\beta} << 2R_E$, then

or

$R_S = 0$

$$\therefore \boxed{I_{CQ} = \frac{V_{EE} - V_{BE}}{2R_E}}$$

* if given,

$V_{CC} = 10V$

$-V_{EE} = -10V$

$V_{BE} = 0.7V$

$R_E = 1k\Omega$

$$\therefore I_{CQ} = \frac{10 - 0.7}{2 \times 1}$$

$$= \frac{9.3}{2}$$

$$\boxed{I_{CQ} = 4.65\ mA}$$ Ans

↓