EEE205: Electronic Device I

Assignment

Fall 2025

Total Marks: 30

Submission (softcopy): 11.00 PM, 27.12.2025

- *Figure in bracket [] next to each question indicates marks for that question.*

Special Notation in the questions: X: Second last digit of your ID, Y: Last digit of your ID.
X.Y --> the . Indicates decimal point.

Question 1 [15 Marks]
[CO1-PO-a, P1&P7]

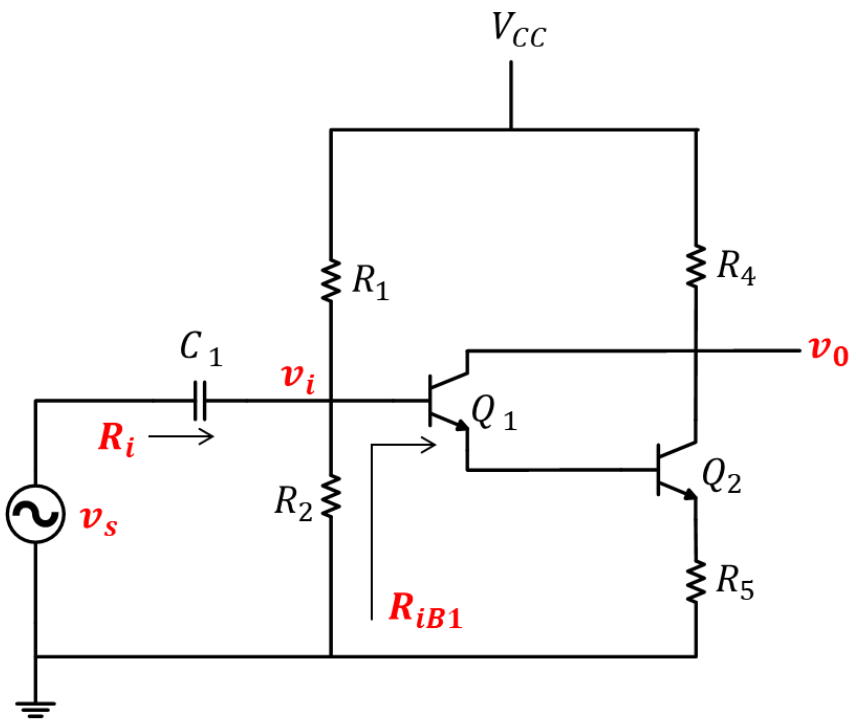

Fig.2

The Multistage BJT Amplifier shown in Fig. 1 has two NPN BJTs, $\boldsymbol{Q_1}$ & $\boldsymbol{Q_2}$ which are connected in cascade and operate in active region. $\boldsymbol{R_1 = (350 + X)k, R_2 = (120 + Y)k, R_4 = 2.2k,\ R_5 = 0.8k, V_{CC} = 10V. \beta = (90 + X + Y)}$ for the BJTs, $\boldsymbol{Q_1}$ *and* $\boldsymbol{Q_2}$. Analyze the Amplifier for Large signal.

1. Draw the Large Signal Equivalent Circuit and Redraw the circuit by replacing the BJTs with their large signal model.[6]
2. Determine the DC Q points for both the BJTs: $\boldsymbol{(V_{CE1}, I_{C1})}$ & $\boldsymbol{(V_{EC2}, I_{C2})}$.[6]
3. Determine the small signal parameters for both the BJTs.[3]

Question 2 [15 Marks]
[CO2-PO-a, P1, P3 &P7]

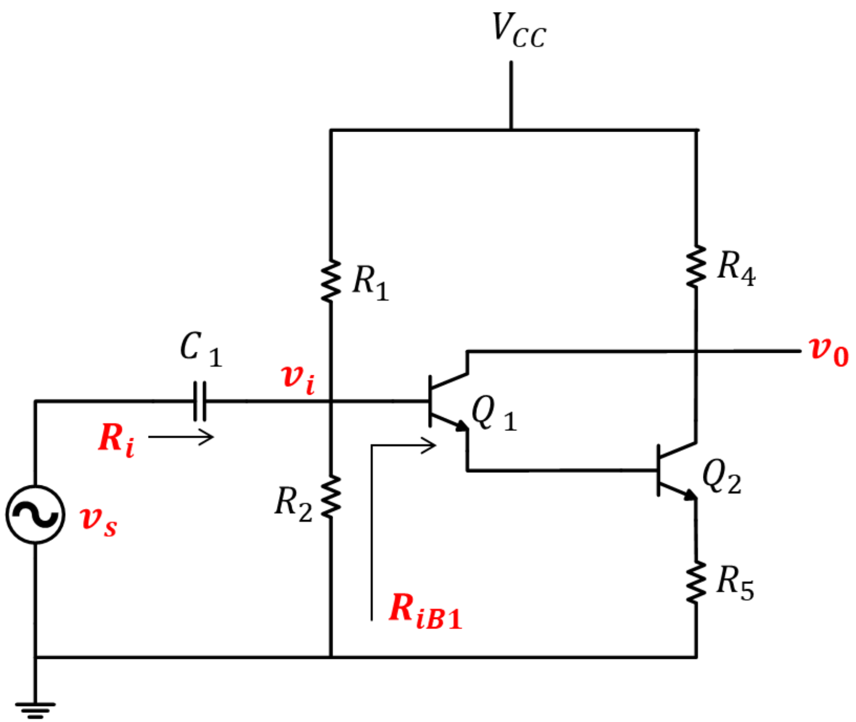

Fig.2

Analyze the same amplifier circuit in Fig.1. for Small Signal

1. Draw the AC equivalent Circuit and simplify it if required.
2. Redraw the circuit replacing the BJTs with the small signal equivalent circuits.
3. Derive the expressions for $\boldsymbol{v_i, v_0, R_{iB1}, R_i, and\ overall\ gain\ A_v}$.

EEE205

Assignment-1

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Section: 04

Answer to the Q. No-1

ID = 24121205

$X = 0$, $Y = 5$

$R_1 = (350 + X) = 350K$

$R_2 = (120 + Y) = 125K$

$R_4 = 2.2K$

$R_5 = 0.8K$

$V_{CC} = 10V$

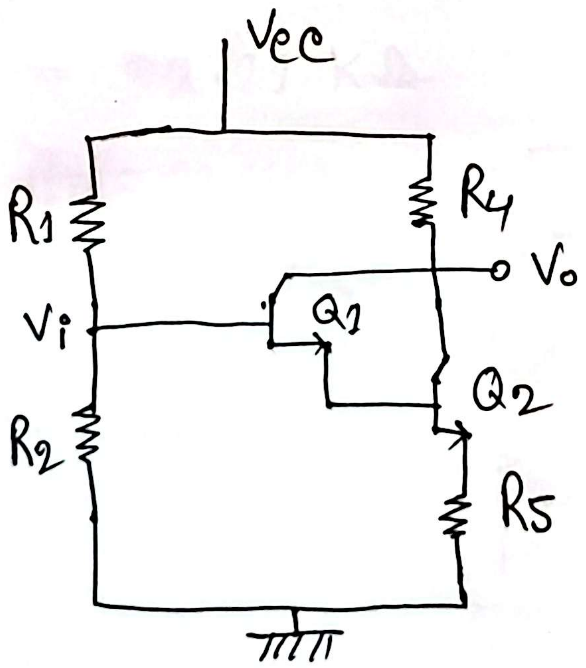
$\beta = (90 + X + Y) = (90 + 0 + 5) = 95$

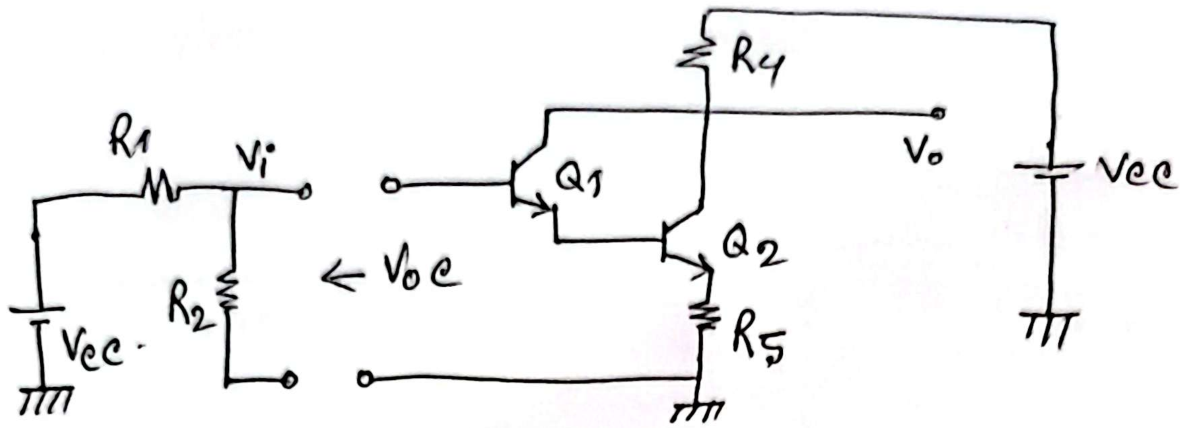
1) large signal equivalent circuit

step

i) turn off all the AC sources.

ii) open the capacitor.





now,

$$V_{TH} = V_{OC} = V_{R2} = \frac{R_2}{R_1 + R_2} \times Vcc$$

$$= \frac{125}{350+125} \times 10$$

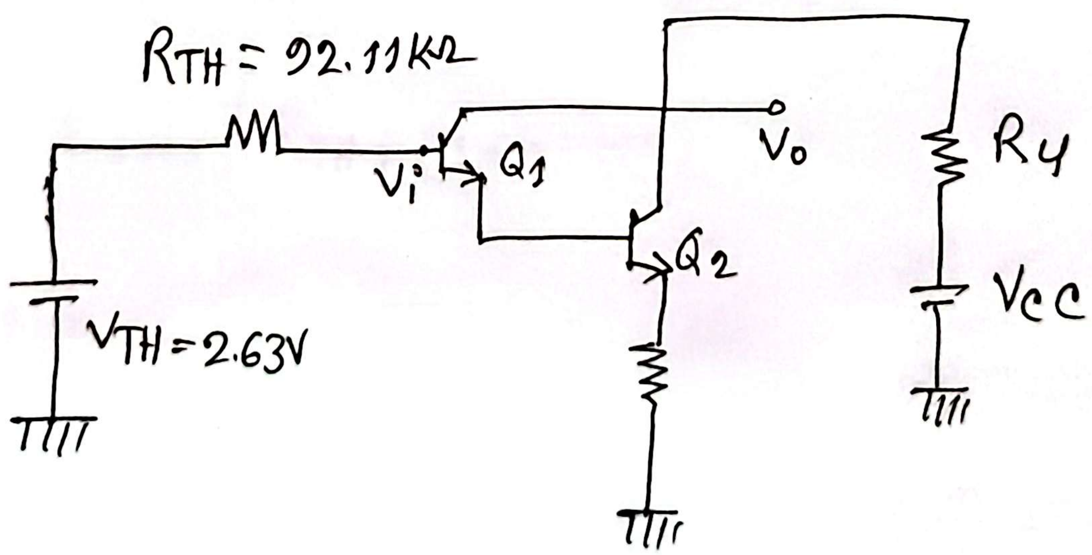
$$= 2.63 \text{ V}$$

and

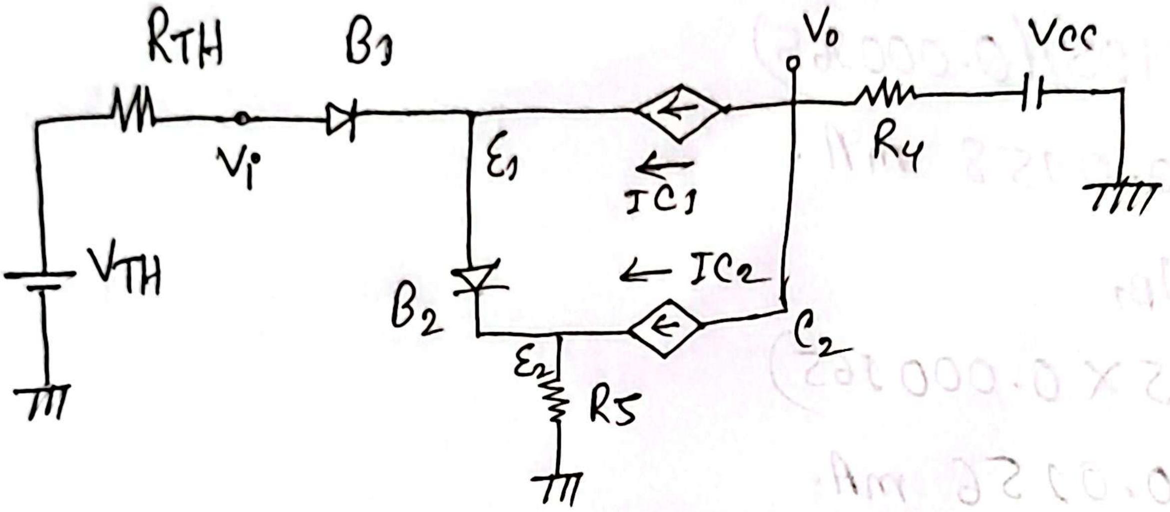
$$R_{TH} = \frac{R_1 \times R_2}{R_1 + R_2}$$

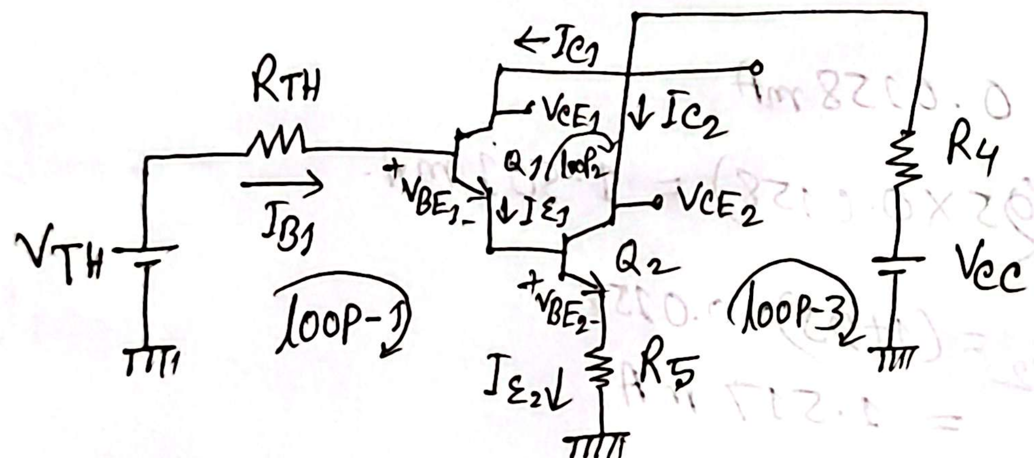
$$= \left(\frac{350 \times 125}{350+125}\right)$$

$$= 92.11 \text{ K}\Omega$$



Here, the Large signal model.





For loop-1,

$$-V_{TH} + I_{B1} R_{TH} + V_{BE1} + V_{BE2} + R_5 I_{E2} = 0$$

$I_{E1} = (1+\beta) I_{B1}$

$I_{E2} = (1+\beta) I_{B2}$

$= (1+\beta) I_{E1}$

$[I_{B2} = I_{E1}]$

$$\Rightarrow V_{TH} = I_{B1} R_{TH} + V_{BE1} + V_{BE2} + (1+\beta)^2 I_{B1} R_5 = 0$$

$$\Rightarrow V_{TH} = I_{B1}\left(R_{TH} + (1+\beta)^2 R_5\right) + V_{BE1} + V_{BE2}$$

$$I_{B1} = \frac{V_{TH} - V_{BE1} - V_{BE2}}{R_{TH} + (1+\beta)^2 R_5} = \frac{2.63 - 0.7 - 0.7}{92.11 + (1+95)^2 \times 0.8}$$

$$= 0.000165 \text{ mA}$$

$I_{E_1} = (1+\beta) I_{B_1}$

$= (1+95)(0.000165)$

$= 0.0158 \text{ mA}.$

$I_{C_1} = \beta I_{B_1}$

$= (95 \times 0.000165)$

$= 0.0156 \text{ mA}.$

$\therefore I_{B2} = I_{E1} = 0.0158 \text{ mA}$

$I_{C2} = \beta I_{B_2} = (95 \times 0.0158) = 1.501 \text{ mA}.$

$I_{E_2} = (1+\beta) I_{B_2} = (1+95) \times 0.0158$

$= 1.517 \text{ mA}.$

For loop-2,

$-R_5 I_{E_2} - V_{BE_2} - V_{CE1} - (I_{C1} + I_{C2}) R_4 + V_{CC} = 0$

$\Rightarrow V_{CE1} = -R_5 I_{E2} - V_{BE2} - (I_{C1} + I_{C2}) R_4 + V_{CC}$

$= -(0.8)(1.517) - 0.7 - (0.0156 + 1.501) 2.2 + 10$

$= 4.75 \text{ V}.$

For loop-3,

$-I_{E_2} R_5 - V_{CE_2} - (I_{C1} + I_{C2}) R_4 + V_{CC} = 0$

$\Rightarrow V_{CE_2} = -I_{E_2} R_5 - (I_{C1} + I_{C2}) R_4 + V_{CC}$

$= -(1.517 \times 0.8) - (0.0156 + 1.501) 2.2 + 10$

$= 5.45 \text{ V}.$

So Here,

$(V_{CE_1}, I_{C_1}) = (4.75V, 0.0156mA)$

$(V_{CE_2}, I_{C_2}) = (5.45, 1.501A)$

Ans

Here consider,

$T = 300K$, $V_T = 25mV$

$$\alpha = \frac{\beta}{1+\beta} = \frac{95}{1+95} = 0.989$$

$$g_{m_1} = \frac{I_{C_1}}{V_T} = \frac{0.0156}{25\times10^{-3}} = 0.63 \ mAV^{-1}$$

$$g_{m_2} = \frac{I_{C_2}}{V_T} = \frac{1.501}{2\times10^{-3}} = 60.04 \ mAV^{-1}$$

$$r_{\pi_1} = \frac{\beta}{g_{m_1}} = \frac{95}{0.63} = 150.79 \ K\Omega$$

$$r_{\pi_2} = \frac{\beta}{g_{m_2}} = \frac{95}{60.04} = 1.58 \ K\Omega$$

$$r_{e_1} = \frac{\alpha}{g_{m_1}} = \frac{0.989}{0.63} = 1.57 \ K\Omega$$

$$r_{e_2} = \frac{\alpha}{g_{m_2}} = \frac{0.989}{60.04} = 0.016 \ K\Omega$$

Ans

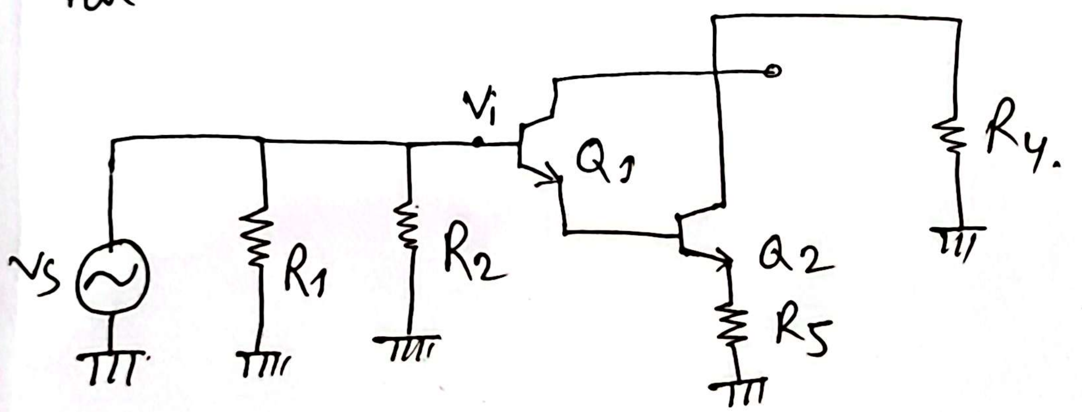
Answer to the Q. No-2

1) AC equivalent circuit

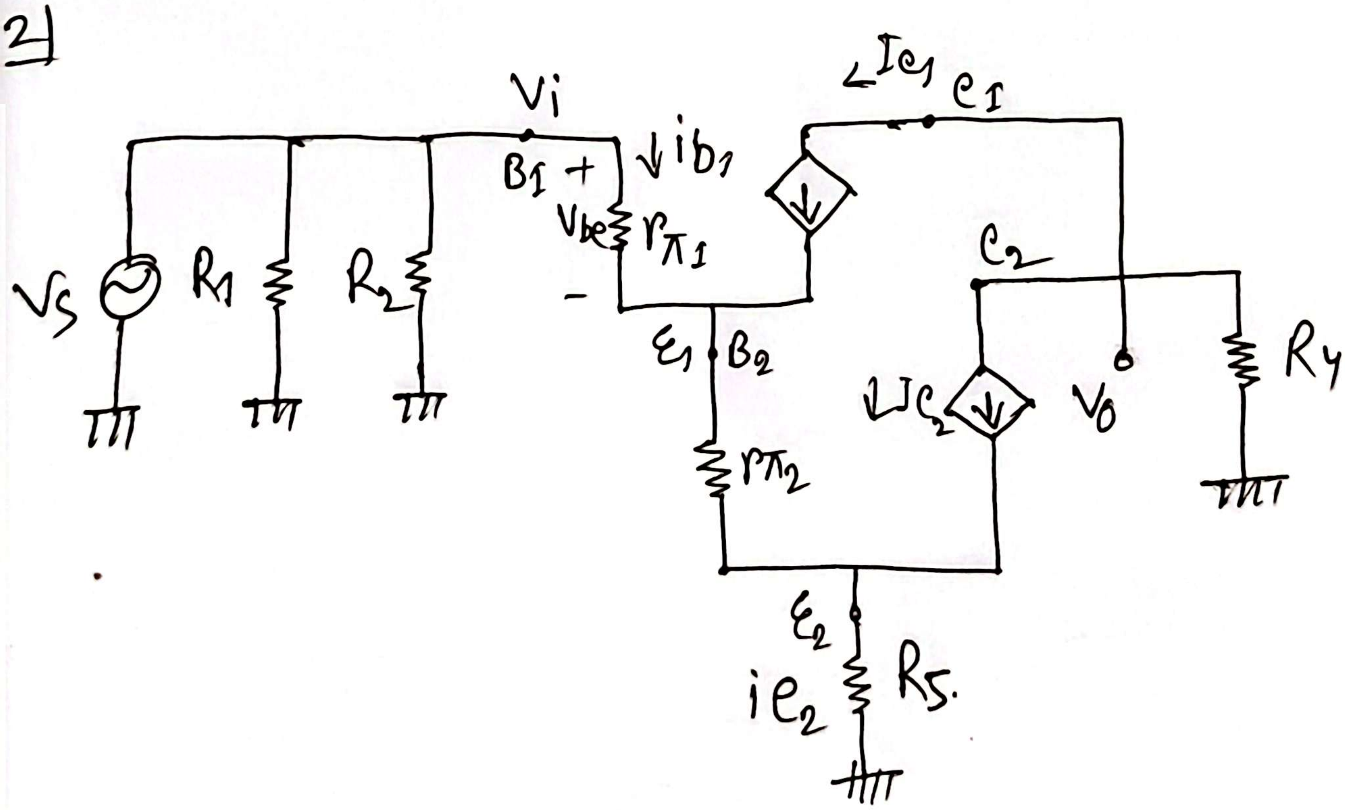
Steps

i) Turn of all DC sources.

ii) All Capacitor shorted.



2)



Hybrid π model.