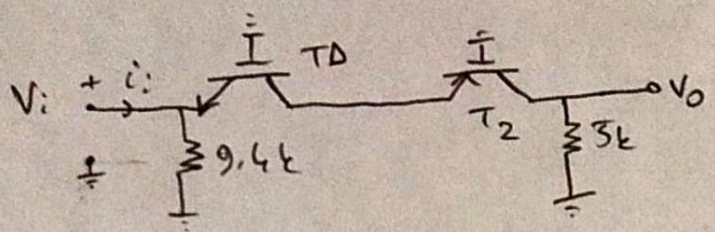
1)

a)



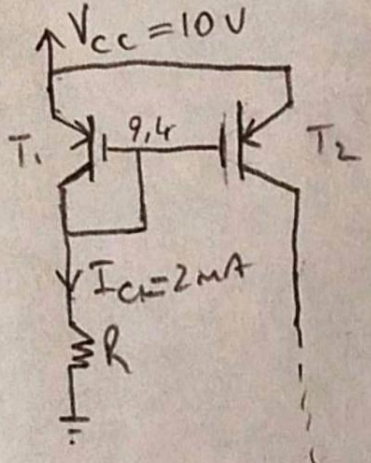
$$r_{bi_D} = \frac{\beta_{TD}}{\frac{g_{m_{T_{D2}}}}{2}} \qquad g_{m_{T_{D2}}} \simeq \frac{1\,mA}{26\,mV} = 38,5\,mS$$

$$\simeq 2,08\,M\Omega$$

$$i_i = \frac{V_i}{r_i} \qquad r_i = r_{bi_D} // 9,4\,k = 9,35\,k\Omega$$

$$= \frac{10\,mV}{9,35\,k\Omega} = 1,07\,\mu A$$

b)



T_1 and T_2 are identical.

$|V_{BE}|=0,6\,V$, $\beta = 200$

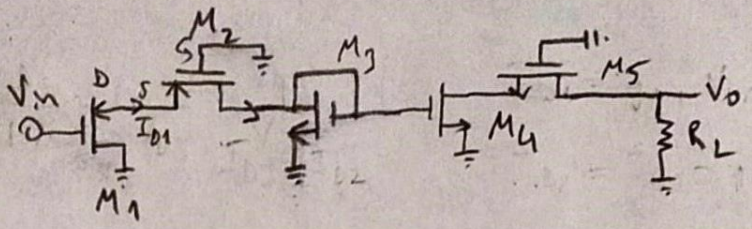
$$R = \frac{9,4\,V}{2\,mA} = 4,7\,k\Omega$$

2)

a) $I_{DQ_1} = I_{DQ_2} = I_{DQ_3} = 50\,\mu A$

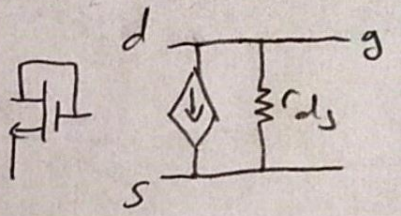
$$I_{DQ_4} = I_{DQ_3} \cdot \frac{\beta_4}{\beta_3} = \underline{\underline{100\,\mu A}}$$

b)



$$\frac{I_{D3}}{V_{in}} = \frac{I_{D3}}{V_{D3}} \cdot \frac{V_{D2}}{V_{S2}} \cdot \frac{V_{S1}}{V_{g1}}$$

$\frac{V_{D2}}{V_{S2}} \cdot \frac{V_{S1}}{V_{g1}} = g_{m1} \cdot R_O$



$$\left.\begin{aligned} \frac{V_{D3}}{V_{in}} &= -g_{m1} \cdot r_{ds3} \\ \frac{I_{D3}}{V_{D3}} &= \frac{1}{r_{ds3}} \end{aligned}\right\} \quad \frac{I_{D3}}{V_{in}} = -g_{m1} = -\sqrt{2\beta_1 \cdot I_{D1}} = \underline{\underline{-0{,}2\ mS}}$$

c) $$\frac{V_{out}}{V_{in}} = \underbrace{(-g_{m1})}_{\substack{M_1, M_2 \\ \text{gain}}} \cdot \underbrace{(-g_{m4} \cdot R_L)}_{\substack{M_4, M_5 \\ \text{gain}}}$$

$$g_{m4} = \sqrt{2\beta_4 I_{D4}} = 0{,}4\ mS$$

$$\frac{V_{out}}{V_{in}} = \underline{\underline{0{,}0008}}$$