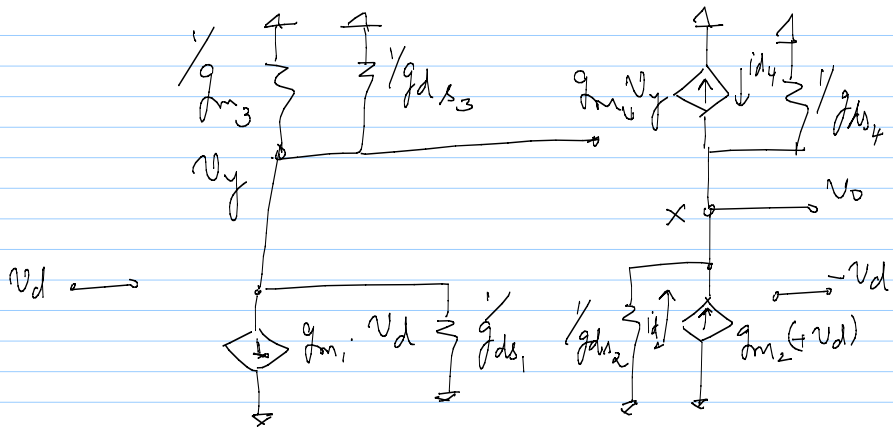
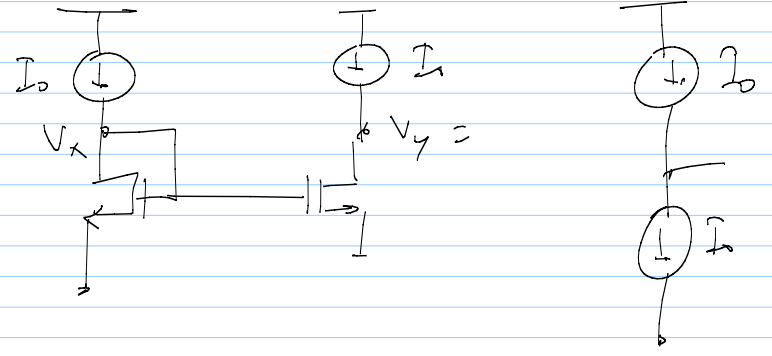
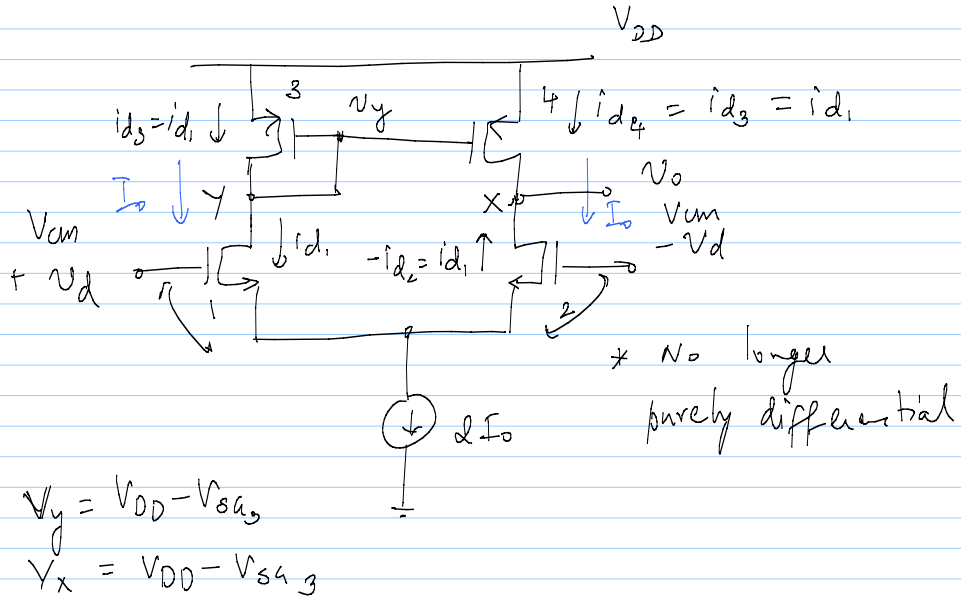


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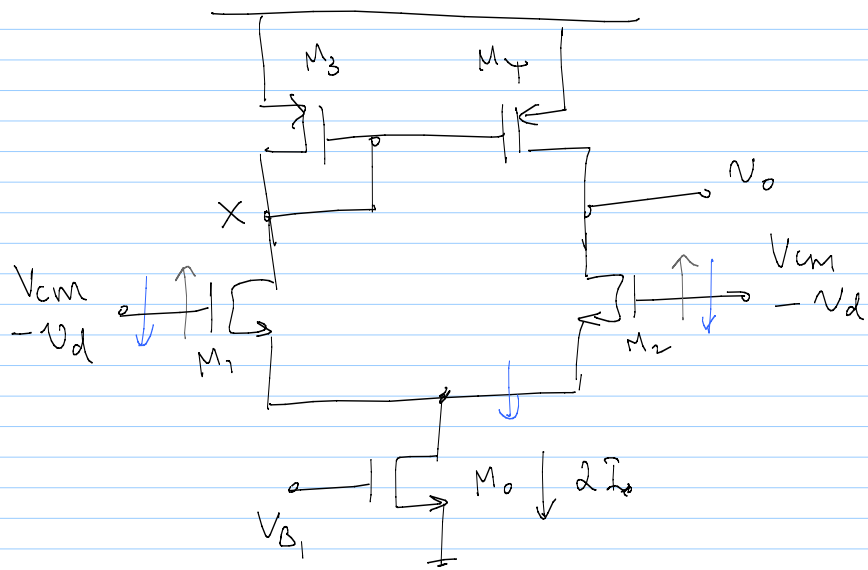
$$V_y = \frac{-g_{m1} V_d}{g_{m3} + g_{ds3} + g_{ds1}}; \quad i_{d4} = g_{m4} \cdot V_y$$

$$i_{d4} = \frac{+g_{m3} \cdot g_{m1}}{g_{m3} + g_{ds3} + g_{ds1}} \cdot V_d \approx g_{m1} V_d$$

$$V_o = (i_{d2} + i_{d4}) \cdot \frac{1}{g_{ds2} + g_{ds4}}$$

$$= \frac{2 g_{m1} V_d}{g_{ds2} + g_{ds4}}$$

$$\frac{V_o}{2 V_d} = \frac{g_{m1}}{g_{ds2} + g_{ds4}} = g_{m1} (r_{ds2} \parallel r_{ds4})$$



$$I_{CMR} \left\{ \begin{aligned} V_{cm, min} &= V_{DSAT_0} \Big|_{2I_0} + V_{AS_{1,2}} \Big|_{I_0} \\ V_{cm, max} &= V_{DD} - V_{S_{4,3}} + V_{T_{1,2}} \end{aligned} \right.$$

$$V_{o, max} = V_{DD} - V_{DSAT_4} \Big|_{I_0}$$

$$V_{o, min} = V_Q - V_{T_{1,2}}$$

\downarrow
 $V_{cm, min}$

