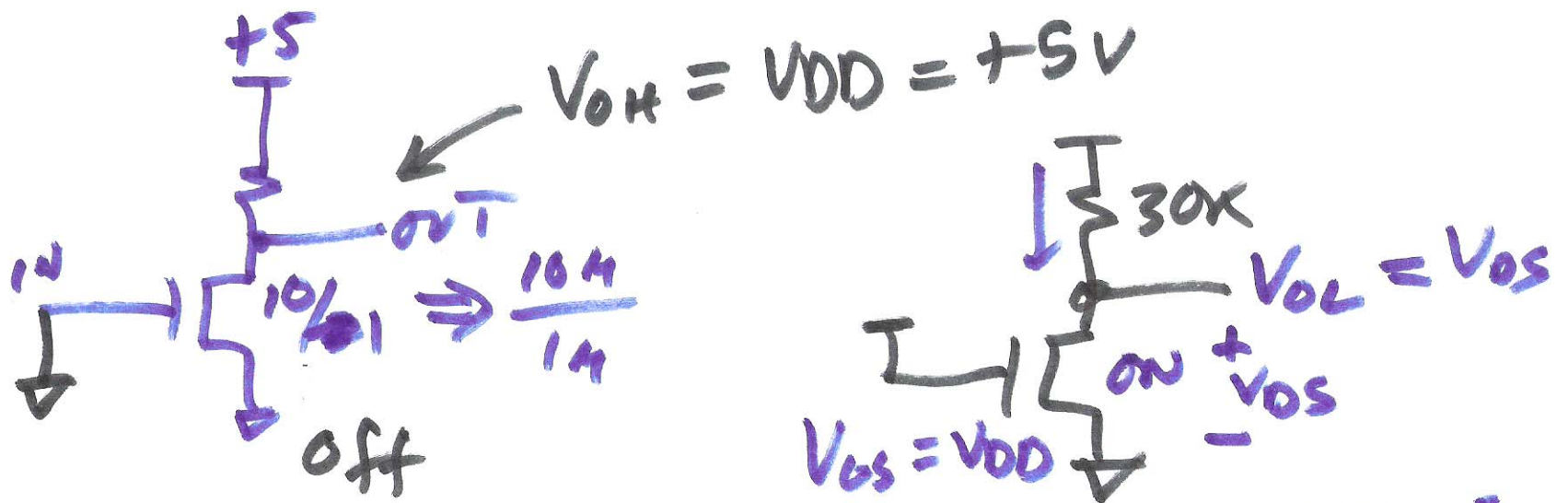
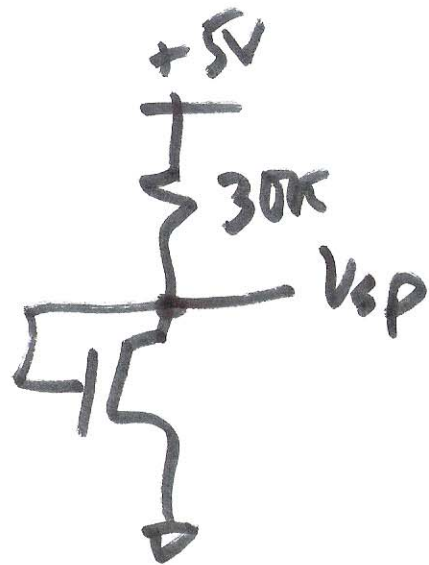


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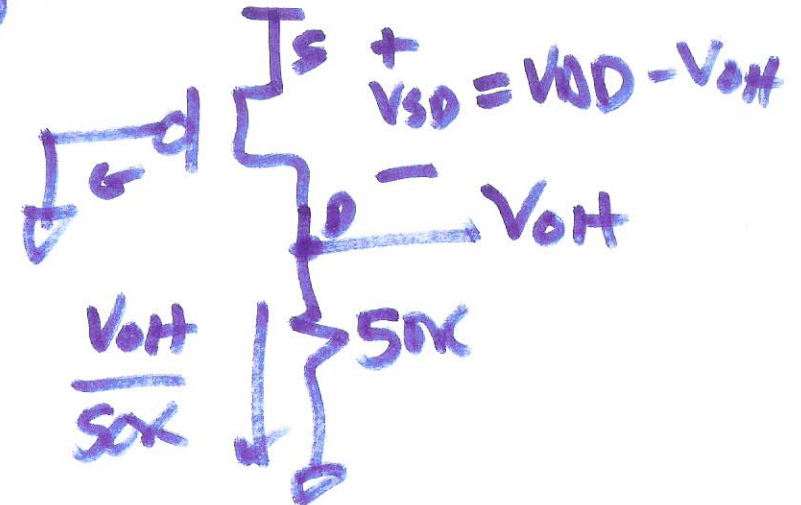
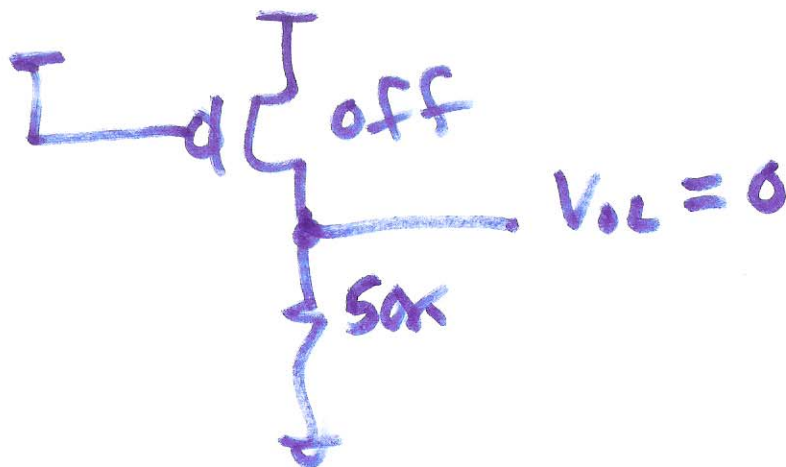
$$\frac{V_{DD} - V_{OL}}{30K} = 120\mu \cdot \frac{10}{1} \cdot \left((V_{DD} - V_{THN}) - \frac{V_{OL}}{2} \right)$$

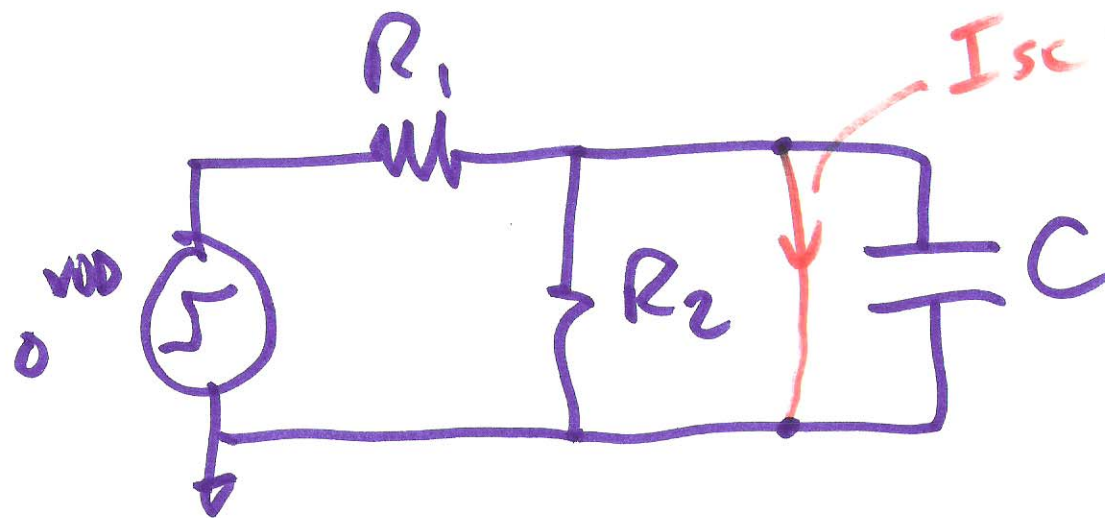


$$\frac{5 - V_{sp}}{30k} = \frac{K_{PN} W}{2 L} (V_{sp} - V_{thn})^2$$

solve for V_{sp}

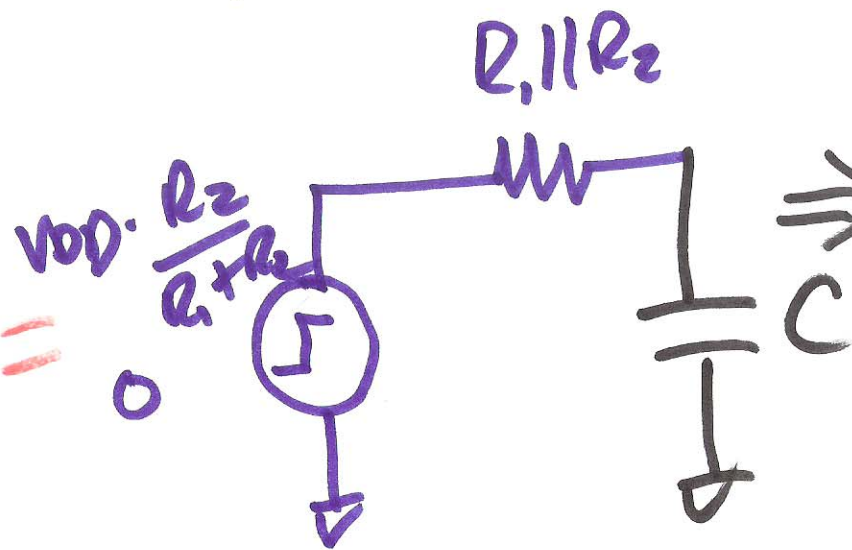
$$V_{sg} = V_{DD} = 5V$$





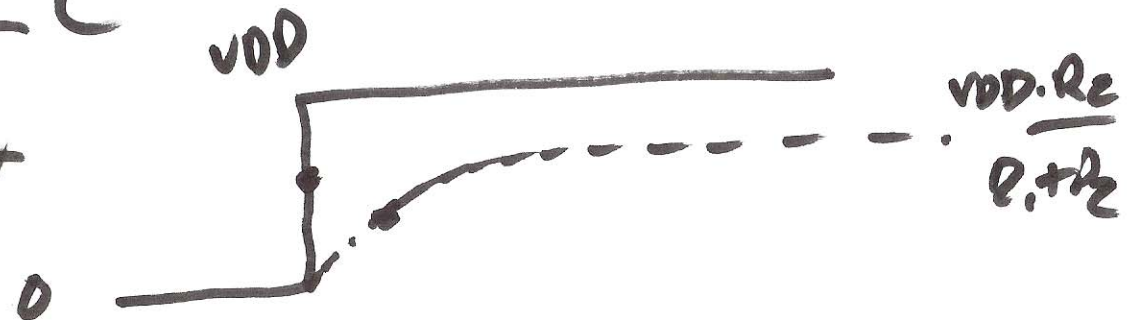
$$I_{sc} = \frac{V_{DD}}{R_1}$$

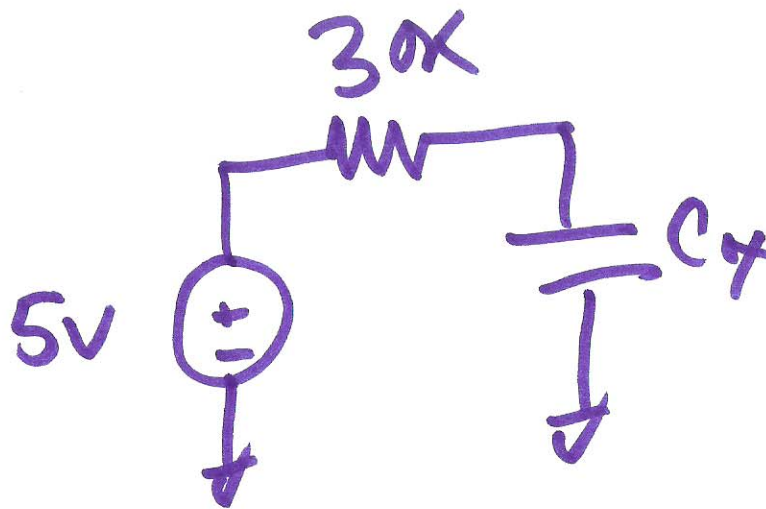
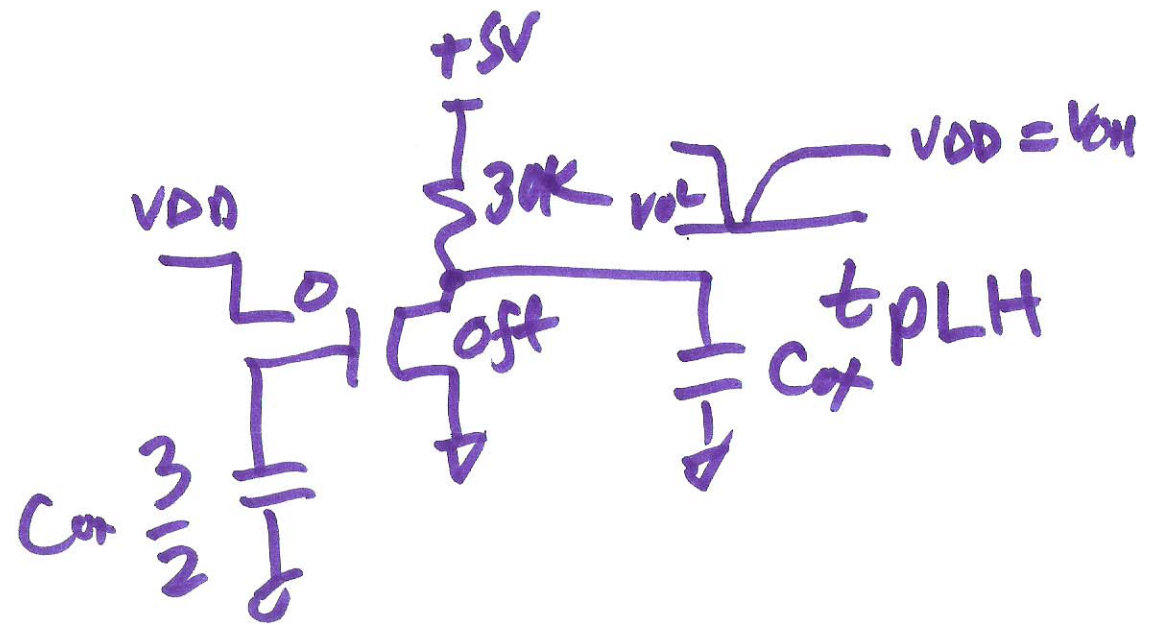
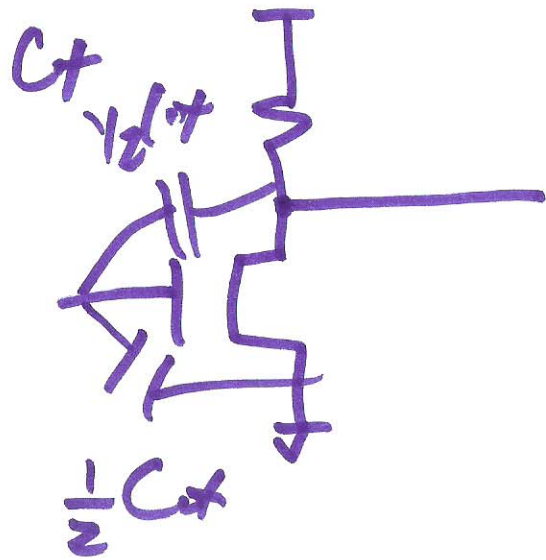
$$R_{TH} = \frac{V_{oc}}{I_{sc}} = \frac{R_1 R_2}{R_1 + R_2} = R_1 || R_2$$



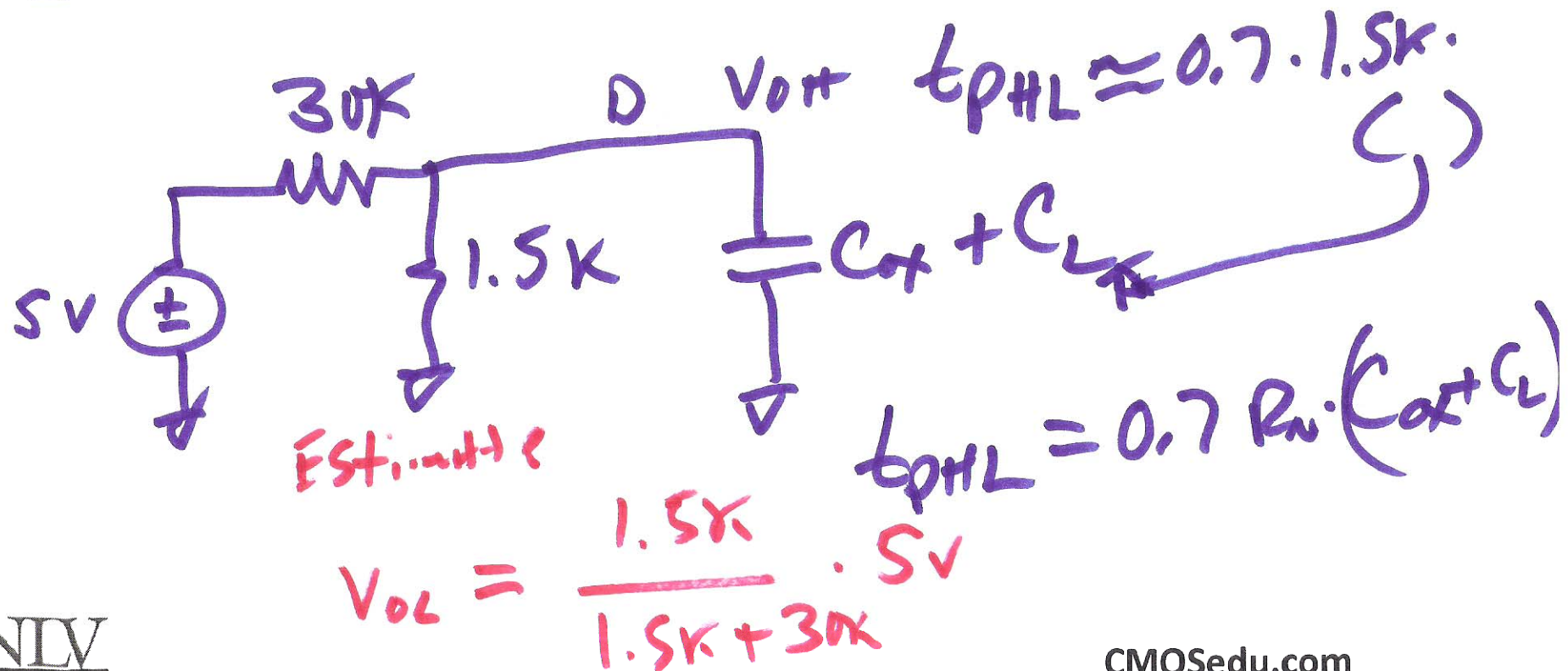
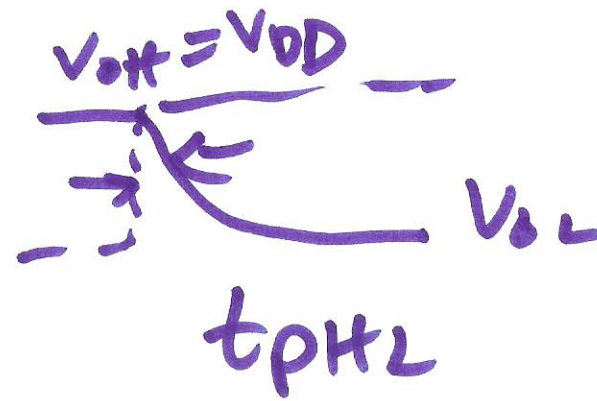
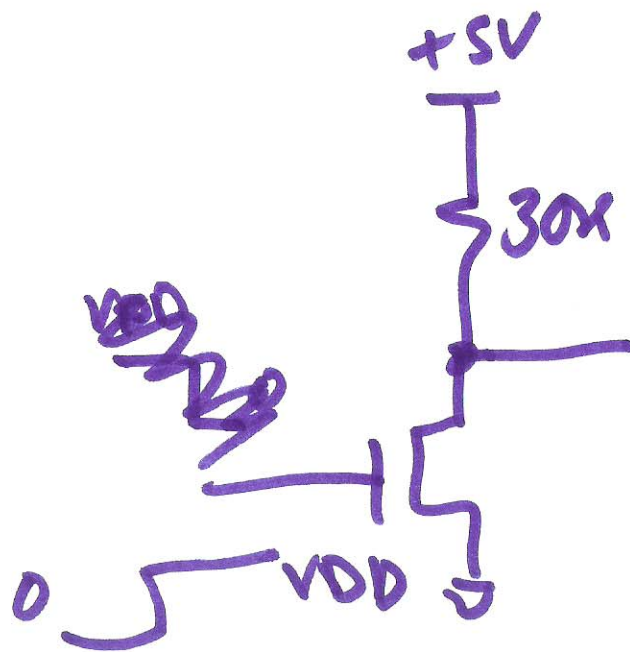
$$V_{oc} = V_{DD} \cdot \frac{R_2}{R_1 + R_2}$$

$$t_d \approx 0.7 R_{TH} C$$





$$t_{PLH} = 0.7 \cdot 30k (C_x + C_L)$$



Buffers

$$t_{PHL} = 0.7 \cdot 4k \cdot 10pF$$
$$= \underline{\underline{28ns}}$$



$$nmos: 20k \cdot \frac{2}{10} = 4k$$

$$pmos: 40k \cdot \frac{2}{20} = 4k$$