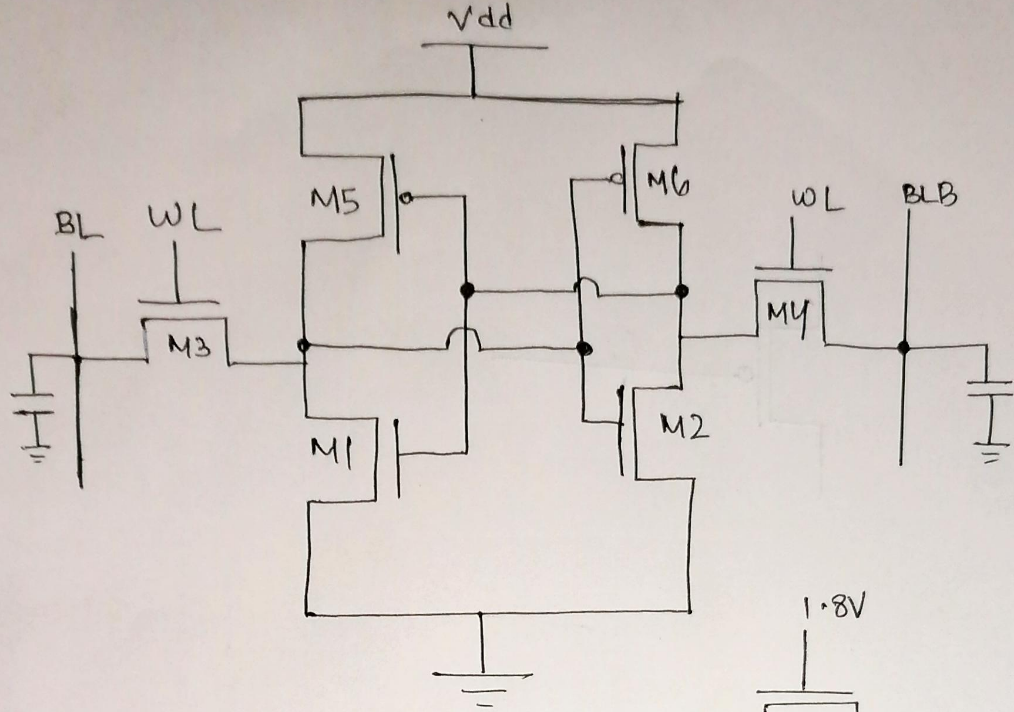
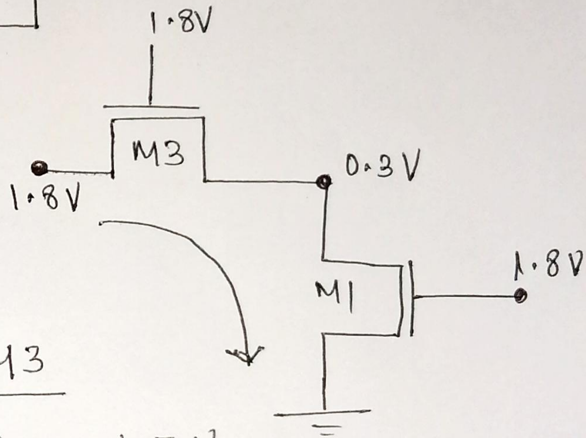
SRAM :



READ :



Region of operation :

M1 :

$V_{GS} = 1.8V$

$V_T = 0.67 V$

$V_{DS} = 0.3 V$

Here,

$V_{GS} - V_T > V_{DS}$

Hence M1 is in linear region.

M3

$V_{GS} = 1.5 V$

$V_T = 0.67 V$

$V_{DS} = 1.5 V$

Here,

$V_{GS} - V_T < V_{DS}$

Hence M3 is in saturation region.

$$I_{M3} = I_{M1} \quad \text{——} \quad (\mathrm{I})$$

$$\Rightarrow I_{M3} = \mu_n C_{ox} \left(\frac{W}{L}\right)_3 \frac{(V_{GS}-V_T)^2}{2}$$

$$= \mu_n C_{ox} \left(\frac{W}{L}\right)_3 \frac{(0.83)^2}{2}$$

$$I_{M3} = \mu_n C_{ox} \left(\frac{W}{L}\right)_3 \times 0.344 \quad \text{——} \quad (\mathrm{II})$$

$$\Rightarrow I_{M1} = \mu_n C_{ox} \left(\frac{W}{L}\right)_1 \left[(V_{GS}-V_T)V_{DS} - \frac{V_{DS}^2}{2}\right]$$

$$= \mu_n C_{ox} \left(\frac{W}{L}\right)_1 \left[1.13 \times 0.3 - \frac{0.3^2}{2}\right]$$

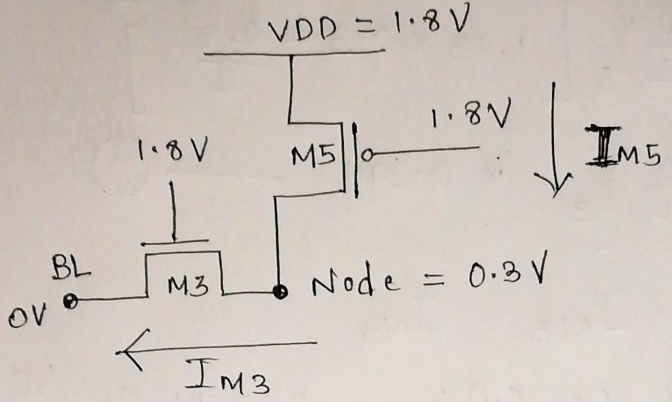
$$I_{M1} = \mu_n C_{ox} \left(\frac{W}{L}\right)_1 \times 0.294 \quad \text{——} \quad (\mathrm{III})$$

from eq^N (I), (II), (III) :

$$\left(\frac{W}{L}\right)_3 \times 0.344 = \left(\frac{W}{L}\right)_1 \times 0.294$$

$$\Rightarrow \boxed{\frac{\left(\frac{W}{L}\right)_3}{\left(\frac{W}{L}\right)_1} \simeq 0.85}$$

WRITE :- for writting ZERO.



Region of operation :-

M5 = PMOS

$V_{SG} = 0V$

$V_{SD} = 1.5V$

$|V_T| = 0.67$

$V_{SD} > V_{SG} - |V_T|$

Hence M5 is in saturation Region.

M3 = NMOS

$V_{GS} = 1.8V$

$V_{DS} = 0.3V$

$V_T = 0.67$

$V_{GS} - V_T > V_{DS}$

Hence M3 is in linear region.

$$I_{M5} = \mu_p \left(\frac{W}{L}\right)_5 \frac{(V_{SG} - V_T)^2}{2} C_{ox}$$

$$\Rightarrow I_{M5} = \mu_p \left(\frac{W}{L}\right)_5 0.224\, C_{ox} \quad (1)$$

$$I_{M3} = \mu_n C_{ox}\left(\frac{W}{L}\right)_3 \left[(V_{GS} - V_T)V_{DS} - \frac{V_{DS}^2}{2}\right]$$

$$= \mu_n C_{ox}\left(\frac{W}{L}\right)_3 \left[1.13 \times 0.3 - \frac{0.3^2}{2}\right]$$

$$\Rightarrow I_{M3} = \mu_n C_{ox}\left(\frac{W}{L}\right)_3 \times 0.294 \quad \text{——— (11)}$$

We know that : $I_{M5} = I_{M3}$

$$\Rightarrow 0.224\, \mu_p \left(\frac{W}{L}\right)_5 = 0.294\, \mu_n \left(\frac{W}{L}\right)_3$$

$$\Rightarrow \frac{\left(\frac{W}{L}\right)_5}{\left(\frac{W}{L}\right)_3} \leq \frac{\mu_n}{\mu_p} \times \frac{0.294}{0.224}$$

$$\Rightarrow \frac{\mu_n}{\mu_p} \approx 5 \text{ (Approx)}$$

$$\Rightarrow \boxed{\frac{\left(\frac{W}{L}\right)_5}{\left(\frac{W}{L}\right)_3} \leq 6.56}$$

We have two equations :

$$\frac{\left(\frac{W}{L}\right)_3}{\left(\frac{W}{L}\right)_1} \leq 0.85 \Rightarrow \frac{\left(\frac{W}{L}\right)_1}{\left(\frac{W}{L}\right)_3} \geq 1.176$$

$$\Rightarrow \left(\frac{W}{L}\right)_1 \geq 1.176\left(\frac{W}{L}\right)_3$$

&

$$\frac{\left(\frac{W}{L}\right)_5}{\left(\frac{W}{L}\right)_3} \leq 6.56$$

Say, $\left(\frac{W}{L}\right)_3 = 250\ nm$

$$\left(\frac{W}{L}\right)_1 \geq 294\ nm$$

$$\left(\frac{W}{L}\right)_5 \leq 1640\ nm$$

Hence we can take sizing of M1, M3, M5 accordingly

Since this is a symmetric structure

M1 = M2

M3 = M4

M5 = M6

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