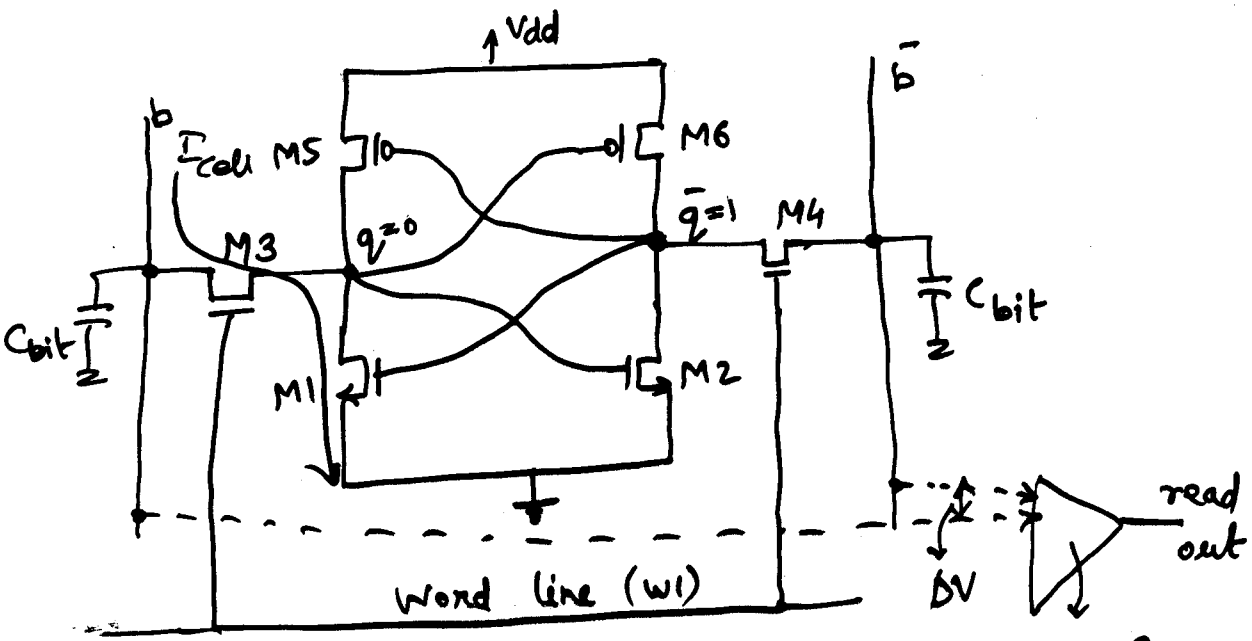
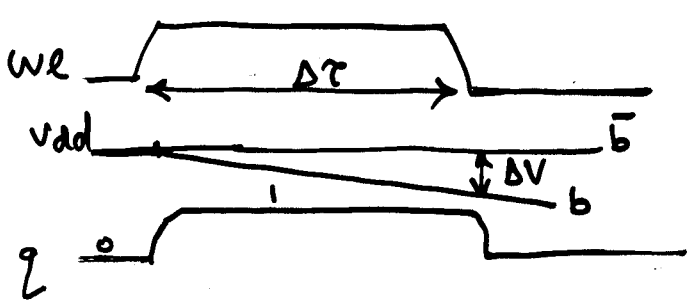
Read operation of the 6T SRAM cell



1) Assume $q = 0$; $\bar{q} = 1$
2) Bit lines are precharged to V_{DD}
3) M1 – ON ; M2 – OFF
4) WL – ON ⇒ M3 and M4 – ON
   ⇓
   (b → M3 → M1 – gnd)
5) b drops, but $\bar{b}$ remains at Vdd.
6) Difference between b and $\bar{b}$ is applied to a sense amplifier.



$$I_{cell} = C_{bit} \cdot \frac{\Delta V}{\Delta \tau}$$

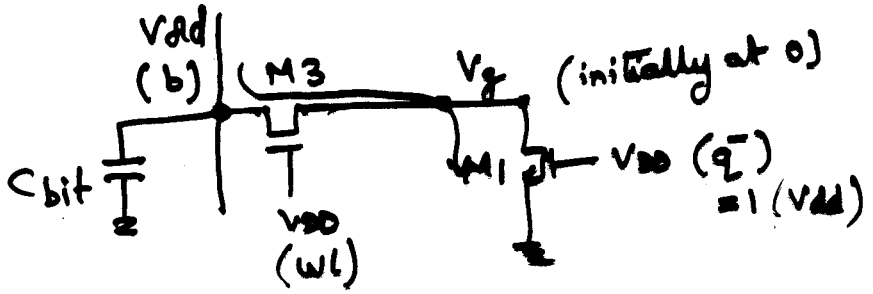
$$\Delta V = \left\{ \frac{I_{cell} \cdot \Delta \tau}{C_{bit}} \right\}$$

Ex. 8.2

Compute W_1 and W_3 given that q node can change 100mV during the read operation.

Assume $C_{bit} = 2pF$ and the sense amplifier requires a transition of 200 mV on the bit line in 2ns. Use 0.13 um technology.

$$I_{cell} = C_{bit} \times \frac{\Delta V}{\Delta t} = 2pF \times \frac{200mV}{2ns} = 200\mu A.$$



$$\left(\frac{W_1}{L_1}\right) \frac{\mu_n C_{ox}}{\left(1+\frac{V_g}{\mathcal{E}_{CN} L_1}\right)} \left[(V_{DD}-V_{T_1}) V_g - \frac{V_g^2}{2} \right] = \frac{(W_3) v_{sat} C_{ox} (V_{DD} - V_g - V_{T_3})^2}{\{(V_{DD} - V_g - V_{T_3}) + \mathcal{E}_{CN} L_3\}}$$

$$\left(\frac{W_1}{W_3}\right) \cong 1.73$$

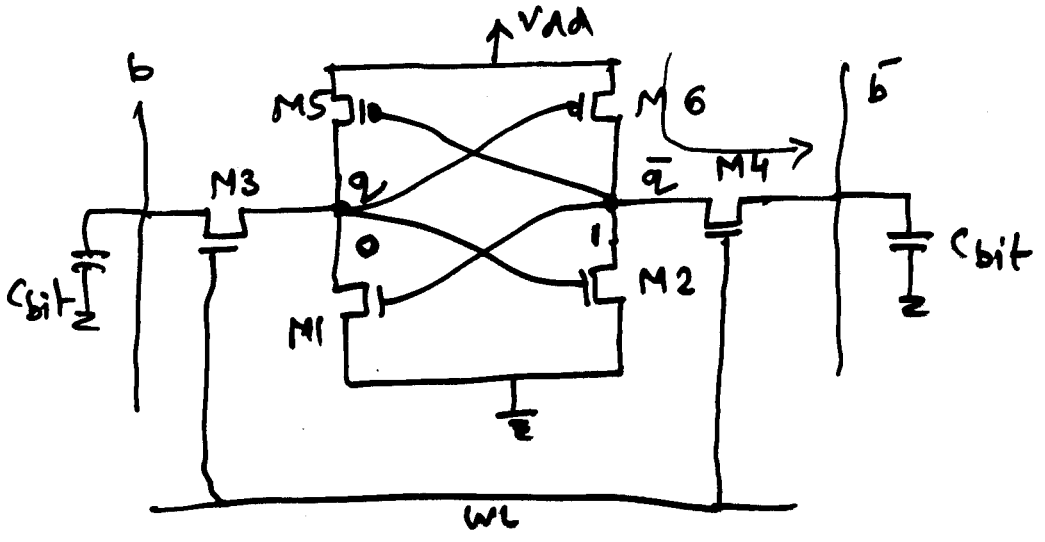
$$200\mu A = I_{cell} = I_3 = \frac{(W_3)(v_{sat}) C_{ox} (V_{DD} - V_g - V_{T_3})^2}{\{(V_{DD} - V_g - V_{T_3}) + \mathcal{E}_{CN} L_3\}}$$

$$\boxed{W_3 = 0.4 \text{ um}}$$

$$\boxed{W_1 = 0.7 \text{ um}}$$

Normal practice → $\boxed{\frac{W_1}{W_3} \cong 1.5}$

Write operation for a 6T SRAM cell



Operation to write 1. → (q = 1)

1) Precharge b and $\bar{b}$ to Vdd.

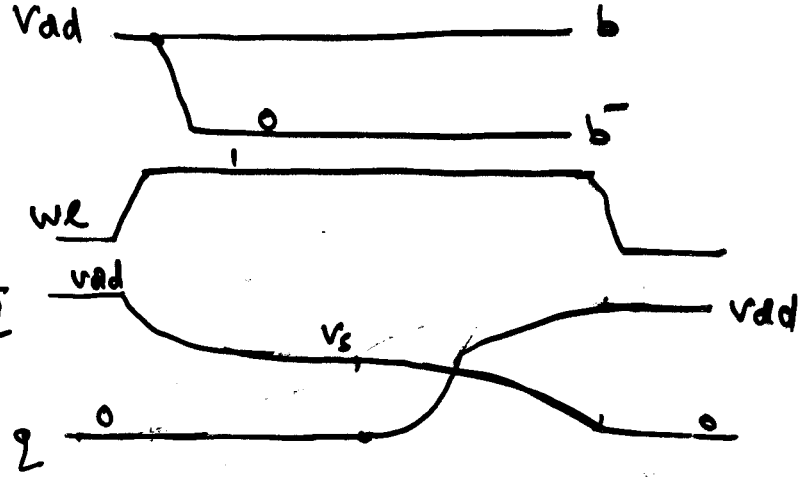
2) Keep b = Vdd but $\bar{b} = 0$.

3) WL is ON, both M3 and M4 are ON

(M6 and M4 → ON)

M4 needs to be stronger than M6.

$$\left(\frac{W_4}{W_6}\right) \geq 1.5 = \left(\frac{W_3}{W_5}\right)$$



Also, $\left(\frac{W_1}{W_3}\right) = \left(\frac{W_2}{W_4}\right) \geq 1.5$

$$\left(\frac{W_1}{W_5}\right) = \left(\frac{W_2}{W_6}\right)$$

$$= (1.5)^2$$

$$= 2.25$$