Assigment 5

Muthya Narayanachary Akhil

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Question 1

Part a

When Q = 1 and $\overline{Q}$ = 0 and WL = H, this implies that M5 and M1 form a voltage ladder. Hence the $\overline{Q}$ is deduced by this equation:

$$\overline{Q} = V_{DD} * \frac{R_{M1}}{R_{M5} + R_{M1}} \tag{1}$$

Hence we can observe the following:

$$1 * \frac{R_{M1}}{R_{M5} + R_{M1}} < 0.4. \tag{2}$$

$$6 * R_{M1} < 4 * R_{M5} = R_{M1} < \frac{2}{3} * R_{M5} \tag{3}$$

This implies that W_{M1} should be greater than 1.5 μm.

Part b

When Q = 1 and $\overline{Q}$=0, M2 and M3 are off, so the writing part is done by M4 and M6 instead. M4 and M6 form a voltage ladder, hence voltage at this point can be given to be:

$$1 * \frac{R_{M6}}{R_{M4} + R_{M6}} < 0.4 \tag{4}$$

$$6 * R_{M6} < 4 * R_{M4} \tag{5}$$

That is, W_{M4} must be less than $\frac{2}{3}$ μm.

Queston 2

Part a

As we know,

$$Q_{overall} = Q_{BL(initial)} + Q_{S(initial)} \tag{6}$$

Based on the data we already khow, we can infer the following:

$$(80fF + 20fF) * V_{final} = 80tF * 1 \quad (7)$$

$$V_{final} = 0.8V \quad (8)$$

Hence the dropping amount is 1 - 0.8 V = 0.2 V

Part b

This results in a potential drop from M1. The top plate of C_s can only reach 1.6 V. To prevent such a voltage drop, M1's gate voltage needs to have $V_{th,M1}$ higher than BL. This would minimally need to be 2.4 V or higher, this process is commonly called bootstrapping.