EE210A: Microelectronics I - Mini-Quiz 4

NAME (in capital)	Roll No

Time: 20 minutes

1) : For the transistor in the following circuit $\mu_n C_{ox} = 200\mu A/V^2$, $V_{tn} = 1V$, Also, $V_{DD} = 5V$.

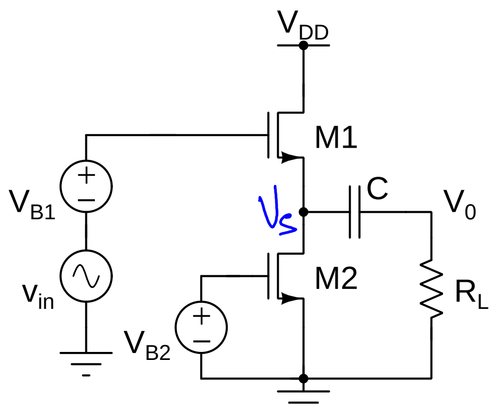


Fig. 1. Problem 1

a) : Assume $W/L = 10$ for both transistors. Find the minimum V_{B1} and V_{B2} such that a quiescent current of 1 mA flows through stack while keeping both transistors in saturation. **[3]**

For M2 : $V_{B2} = V_{tn} + \sqrt{\dfrac{2 I_D}{\mu_n C_{ox} (W/L)_2}}$

$= 1 + \sqrt{\dfrac{2 \times 1m}{0.2m \times 10}} = 2V$

For minimum V_{B1}, V_s has to be minimum.

$\therefore V_{B1} - V_s = V_{tn} + \sqrt{\dfrac{2 I_D}{\mu_n C_{ox} (W/L)_1}}$

$\Rightarrow V_{B1(min)} = V_{s\,min} + 2V$

$V_{s\,min} = V_{B2} - V_{tn} = 1V \quad \therefore V_{B1(min)} = 3V.$

b) : What changes in the W/L would you do to ensure M2 is away from the edge of saturation region by 500 mV while maintaining 1 mA of quiescent current? **[4]**

Must increase V_S $\Rightarrow$ Must reduce $V_{ov}|_{M1}$ ($\because V_{B1}$ is constant)

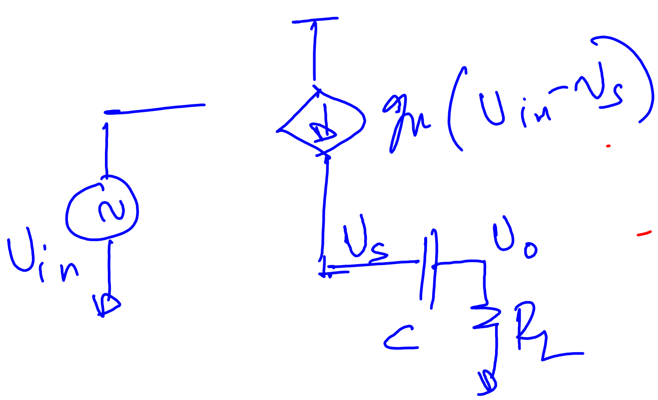
$$\therefore V_S = V_{B1} - (V_{tn} + V_{ov1})$$

$$\Rightarrow 1.5 = 3 - \left(1 + \sqrt{\frac{2 I_{DS}}{\mu C_{ox} (W/L)_1}}\right)$$

$$\Rightarrow \sqrt{\frac{2 \times 1m}{0.2m \times (W/L)_1}} = 0.5$$

$$\Rightarrow (W/L)_1 = 40$$

c) : What is the constraint on R_L to ensure that v_0 is independent of R_L? **[3]**



$$g_m(v_{in} - v_s) = \frac{v_s}{\frac{1}{j\omega C} + R_L}$$

$$\Rightarrow v_s = \frac{g_m (R_L + 1/j\omega C) v_{in}}{1 + g_m (R_L + 1/j\omega C)}$$

$$\Rightarrow v_0 = \frac{v_s R_L}{R_L + 1/j\omega C} = \frac{v_{in}\, g_m R_L}{1 + g_m (R_L + 1/j\omega C)}$$

$\therefore R_L \gg 1/\omega C$

and $g_m R_L \gg 1$

$\Rightarrow R_L \gg 1/g_m$

It's okay if someone has assumed $C \to \infty$ and done the analysis.