EE210A: Microelectronics I

Problem Set 3

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Assume $\mu_n C_{ox} = 200\mu A/V^2$ and $V_{tn} = 1V$ for all transistors in the problem set.

1) : Consider V_{DD} = 5V, $W/L = 10$, and $R_L = 1k\Omega$.

Plot V_D with respect to V_B, when V_B is swept from 0 to $5V$. Mark the points corresponding to the regions of operation in the plot.

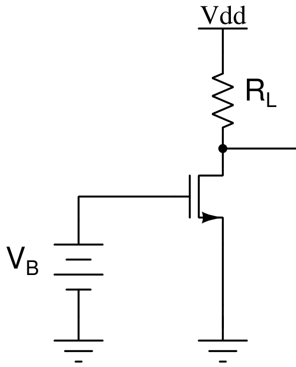

Figure 1: Problem 1.

2) : Consider the Fig. 2. $V_{DD} = 5V$, R_L = 10kΩ.

a) : Find V_B and W/L of M1 for a small signal gain of -10 between v_i and v_o. Is the solution unique?
b) : If $v_i = V_p \sin(\omega_0 t)$, find V_B and W/L while ensuring maximum possible V_P for which $M1$ remains in saturation and away from cutoff (Use Q-point + incremental model for analysis), and ensuring a gain of -10.

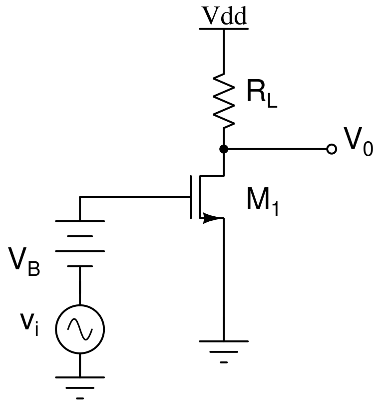

Figure 2: Problem 2.

3) : Consider Fig. 3. $V_{DD} = 5V$, $(W/L)_1 = 10$, $(W/L)_2 = 5$, $V_B = 2V$, $R_1 = 2k\Omega$, $R_2 = 1k\Omega$.

a) : Find the small signal gain between v_i and v_{d1}, and between v_i and v_{d2}.
b) : If v_i=$V_p$sin($\omega_0 t$), find the maximum V_p such that $M1$ remains in saturation and away from cutoff region of operation. (Use linear incremental analysis)
c) : If $v_i = V_p \sin(\omega_0 t)$, find the maximum V_p such that both $M1$ and $M2$ remain in saturation and away from cutoff region of operation. (Use linear incremental analysis)
d): Sketch the waveforms at the gates and the drains of $M1$ and $M2$ under these conditions. e): If another common-source stage is cascaded to V_{D2}, comment on the maximum allowable amplitude of the input sinusoid with respect to the circuit shown in the figure.

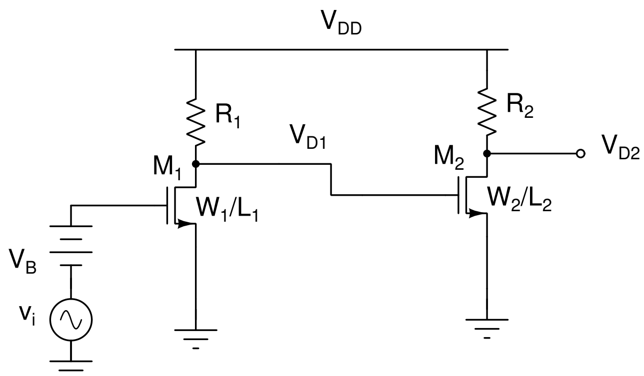

Figure 3: Problem 3.

4) : Sketch the incremental (small-signal) Norton's equivalent network for the following configurations. Replace the transistor with its small signal model, assuming saturation region of operation. (Note that the input v_i has not been applied between the gate and source. Make necessary adjustments in your KCL equations.)

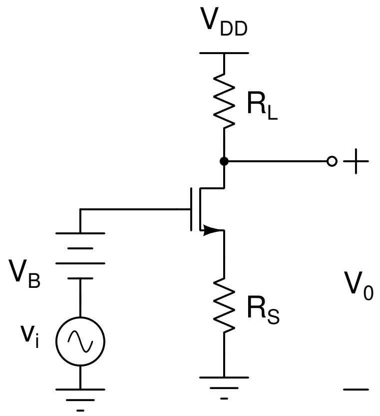

Figure 4: Problem. 4a

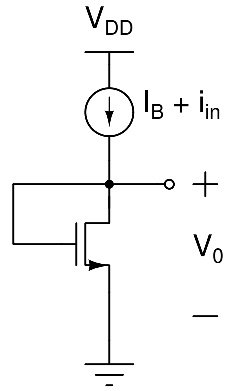

Figure 6: Problem. 4c

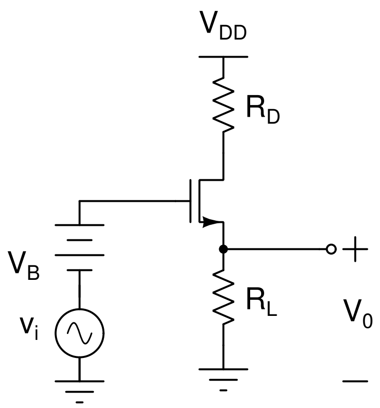

Figure 5: Problem. 4b

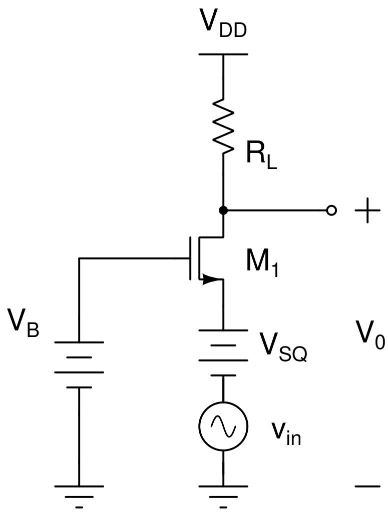

Figure 7: Problem. 4d

5) : Consider the Fig. 8. V_{DD}=3V, $R_L = 1k\Omega$, $(W/L) = 10$.

a) : Find V_B such that the quiescent V_0=0.5V.
b) : What is the small signal gain between v_i and v_o?
c) : If $v_i = V_p \sin(\omega_0 t)$, what is the maximum V_p that you can apply while ensuring $M1$ remains in the saturation and away from the cutoff. (Use quiescent + incremental model for analysis)

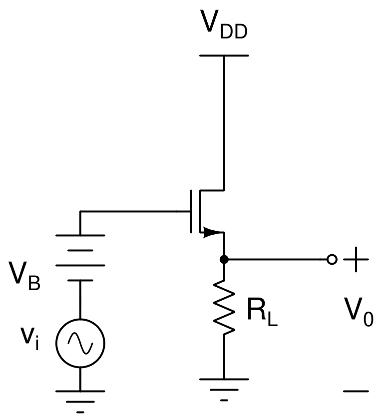

Figure 8: Problem 5.