EE210A: Microelectronics I

Problem Set 8

Instructor: Imon Mondal, imon@iitk.ac.in

1) : Consider V_{DD}=5V, $R_1 = 3k\Omega$, $R_2 = 2k\Omega$, $R_3 = 1k\Omega$, $R_D = 3k\Omega$, $|V_{tp}| = 1V$, $\mu_p C_{ox} = 100\mu A/V^2$, $W/L = 20$, $C_1 = 10pF$, $C_2 = 1pF$ (Ignore CLM)
a) : Find $v_o(j\omega)/v_i(j\omega)$.
b) : Plot the bode-plot for the gain and phase of $v_o(j\omega)/v_i(j\omega)$.
c) : What are the corner frequencies?
d) : What are the pole and zero locations of $v_o(s)/v_i(s)$?

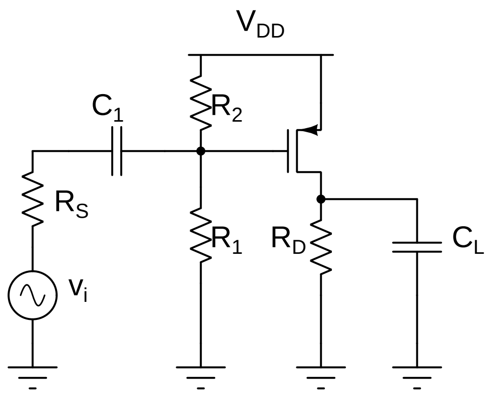

Figure 1: Problem 1.

2) : Consider $\mu_n C_{ox} = 200\mu A/V^2$, $\mu_p C_{ox} = 100\mu A/V^2$ $I_o = 2mA$, $|V_{tp}| = 1V$ $\lambda_n = \lambda_p = 0.1V^{-1}$ and $V_{DD} = 3V$.
a) : Find v_o/v_i (make necessary approximations).
b) : Find the max(V_{cm}) and min(V_{cm}) which you can have while keeping all transistors in saturation. Assume $V_{o(quiescent)}$ = 1V, 1.5V
c) : How will you change the design to increase max(V_{cm}) by 500mV?

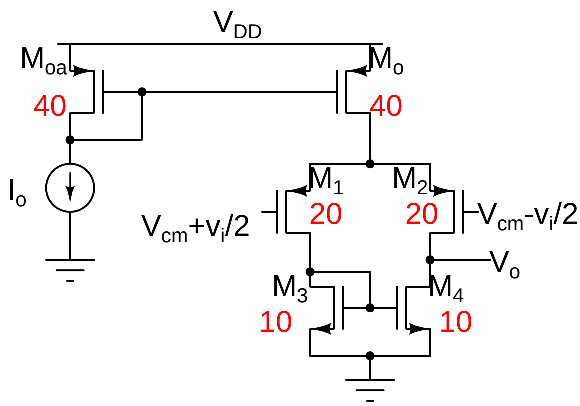

Figure 2: Problem 2.

3) : Refer figure3.
a) : Find v_{o1}/v_i and v_{o2}/v_i symbolically.
b) : Find incremental and quiescent v_X.
c) : Find the max and min V_i which will keep all the transistors in saturation. Assume $R << r_{ds}$ for any transistor.
d): If the inputs to M_1 and M_2 are $V_{cm} + v_{icm}$ then find the v_{o1}/v_{icm}, and the swing limits of v_{icm}.

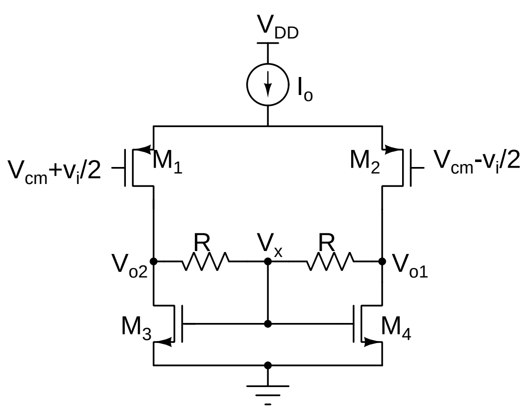

Figure 3: Problem 3.

4) : Assume M_1 is biased in saturation, $C1 \to \infty$, $R_1||R_2 \to \infty$. (Ignore CLM)
a) : Find $v_o(s)/v_i(s)$.
b) : Sketch the bode-magnitude plot of $|v_o(j\omega)/v_i(j\omega)|$ while marking the poles and zeros. Assume the poles are far apart from each other.

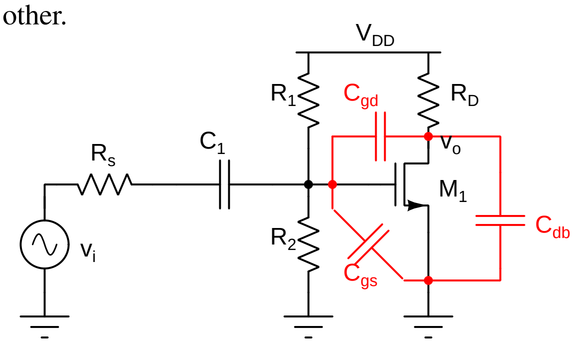

Figure 4: Problem 4.

5) : Figure (i) and (ii) shows two possible output stages, being driven by a G_m (which has an incremental o/p resistance r_1). Assume $G_m r_1$=100.
a) : Find the quiescent V_o in (i) and (ii).
b) : Find the open-loop o/p impedance in both the architectures.
c) : Find the max and min possible V_o. Assume I_o requires at least 100mV across it to behave like a current source.

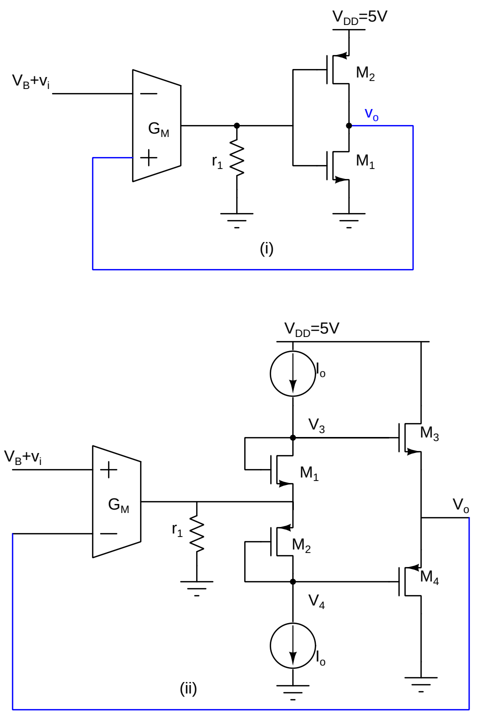

Figure 5: Problem 5.