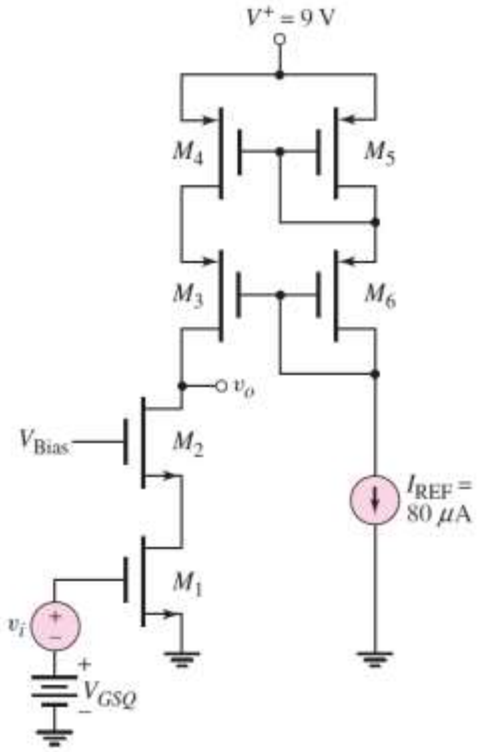
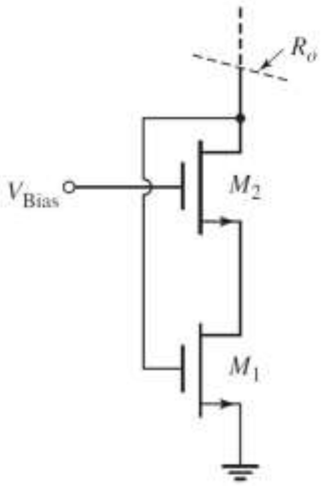
Electronics II, EXAM-3, Spring 2019
Department of Communication Engineering, National Central University
May 17, 2019, Prof. Dah-Chung Chang (E1-311)

Exam Time: 10:00AM-11:50AM, 2018/5/17

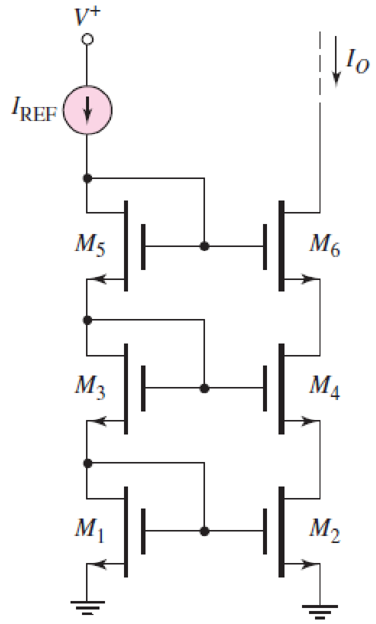
1. (25%) The transistor parameters are $V_{TN} = 0.6V, V_{TP} = -0.6V, k_n' = 100\mu A/V^2, k_p' = 60\mu A/V^2$, and $\lambda_n = \lambda_p = 0.04V^{-1}$. The values of W/L for M_1 and M_2 are 25, and those of all other transistors are 50. The value of V_{GSQ} is such that $I_{DS1} = 80\mu A$ and all transistors are biased in the saturation region. Determine the small-signal voltage gain $A_v = v_o / v_i$.

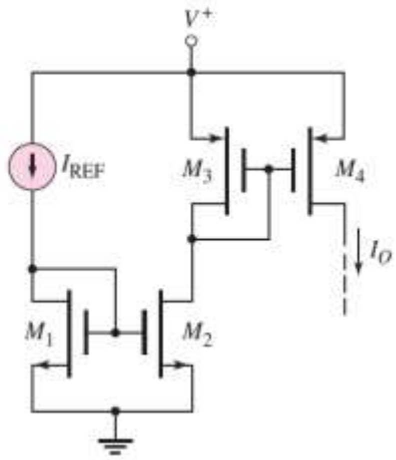


2. (25%) Assume that both transistors are biased in the saturation region, and that $g_{m1} = g_{m2} = g_m$ and $r_{o1} = r_{o2} = r_o$. Suppose $g_m \gg 1/r_o$, show that $R_o = \dfrac{2 + g_m r_o}{g_m(1 + g_m r_o)} \approx \dfrac{1}{g_m}$.



3. (30%) Let I_{REF} = 0.2 mA, K_n = 0.2 mA/V^2, V_{TN} = 1 V, and λ = 0.02 V^{-1}. (All transistors are matched.) Determine the output resistance looking into the drain of M_6.





4. (20%) Transistor parameters are $V_{TN} = 0.4\text{V}$, $k_n' = 100\mu\text{A/V}^2$, $V_{TP} = -0.6\text{V}$, $k_p' = 40\mu\text{A/V}^2$, and $\lambda_n = \lambda_p = 0$. The width-to-length ratios are $(W/L)_1 = 15$, $(W/L)_2 = (W/L)_3 = 9$, and $(W/L)_4 = 20$. Let $I_{REF} = 200\mu\text{A}$, determine
(a) I_O, and
(b) the minimum V_{SD4} such that M_4 is biased in the forward active mode.