Electronics II, Exam-3, Spring 2016

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May 13, 2016, Prof. Dah-Chung Chang (E1-311)

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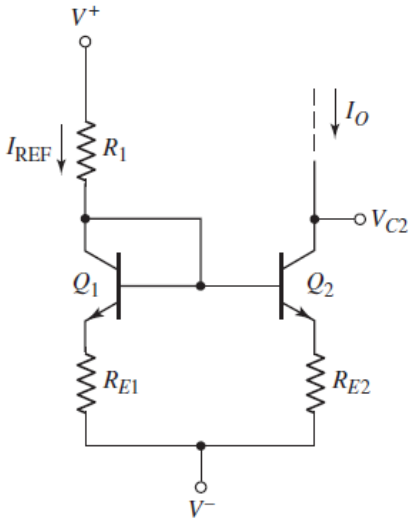
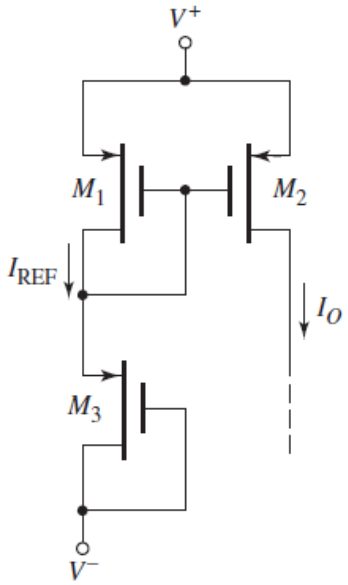
1. (15%) Consider the circuit depicted below, in which the transistors are matched. Assume that base currents are negligible and that $V_A = \infty$. Show that

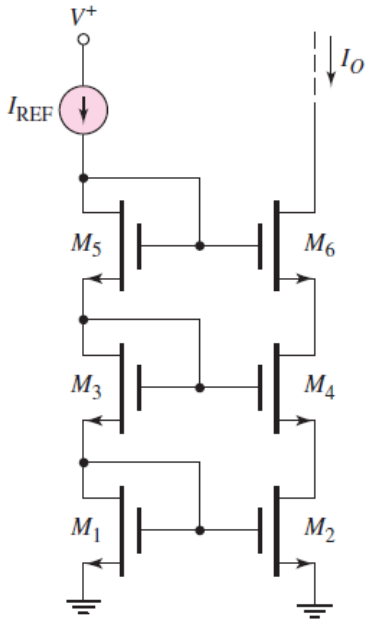
$$I_O R_{E2} - I_{REF} R_{E1} = V_T \ln\left(\frac{I_{REF}}{I_O}\right).$$



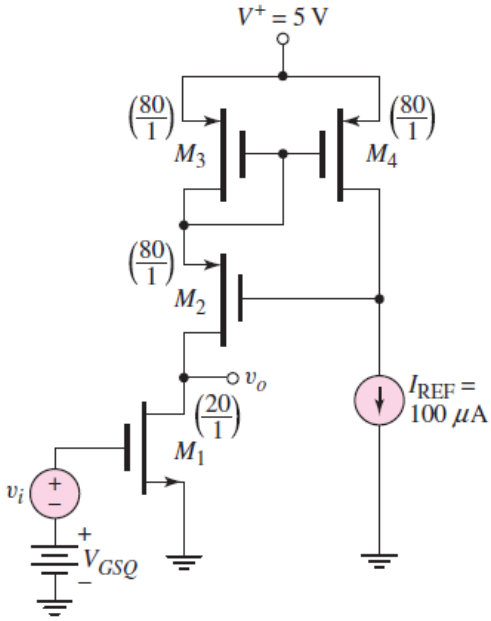
2. (20%) Assume the circuit is biased at $V^+ = +5$ V and $V^- = -5$ V, and assume the transistor parameters are $V_{TP} = -0.5$ V, $k_p' = 50\ \mu$A/V^2, (W/L)$_1$ =(W/L)$_2$ = 15, (W/L)$_3$ = 3, and $\lambda = 0$. Determine I_O and $V_{SD2(sat)}$.



3. (20%) Let $I_{REF} = 0.2$ mA, $K_n = 0.2$ mA/V^2, $V_{TN} = 1$ V, and $\lambda = 0.02$ V^{-1}. (All transistors are matched.) Determine the output resistance looking into the drain of M_6.



4. (25%) The parameters of the transistors are V_{TN} = 0.6 V, V_{TP}= −0.6 V, k_n' =100μA/V^2, k_p' = 60μA/V^2, and λ_n =λ_p =0.02V^{-1}. The width-to-length ratios are shown in the figure. The value of V_{GSQ} is such that I_{D1} = 100μA, and M_1 and M_2 are biased in the saturation region. Determine the small-signal voltage gain $A_v = v_o/v_i$.



5. (20%) The parameters of the transistors are V_{TN} = 0.8 V, V_{TP} = −0.8 V, k_n' = 100μA/V^2, k_p' = 60μA/V^2, and λ_n =λ_p = 0. The transistor (W/L) ratios are given in the figure. For R = 100 kΩ, determine (a) I_{REF}, (b) I_1, I_2, I_3, and I_4.