Electronics II, Exam-3, Spring 2020

Department of Communication Engineering, National Central University

22 May, 2020, Prof. Dah-Chung Chang (E1-311)

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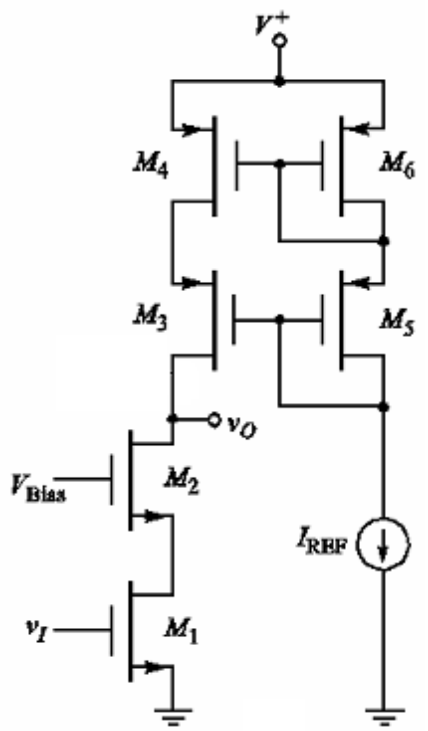
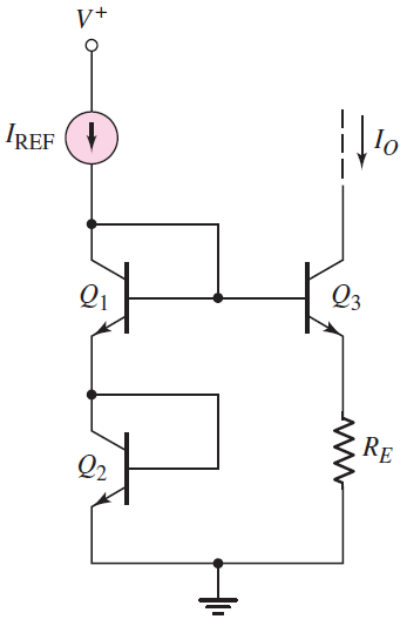
1. (25%) Assume that all transistors are matched. The circuit acts as an amplifier. Let K_n and K_p denote the conduction parameter for NMOS and PMOS, and λ_n and λ_p the channel-length modulation parameter for NMOS and PMOS, respectively. Show that the voltage gain is

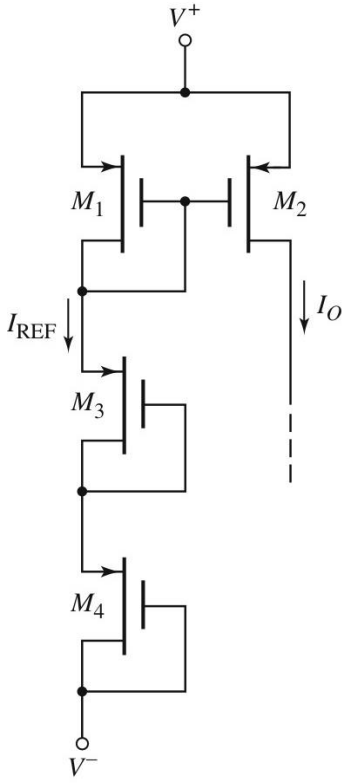
$$A_v = \frac{V_o}{V_i} \approx \frac{-4K_n}{I_{REF}(\lambda_n^2 + \lambda_p^2)}$$



2. (30%) Assume that all transistors are matched. Neglect base currents and assume $V_A = \infty$.
   (a) Derive the expression for I_O in terms of I_{REF} and R_E.
   (b) Determine the value of R_E such that $I_O = I_{REF} = 100\mu\text{A}$. Assume $V_{BE} = 0.7\text{V}$ at a collector current of 1 mA.



3. (20%) The circuit is biased at $V^+ = +5V$ and $V^- = -5V$. The transistor parameters are:
$V_{TP} = -1.2V, k'_p = 80\mu A/V^2, \lambda = 0, (W/L)_1 = (W/L)_2 = 25,$ and
$(W/L)_3 = (W/L)_4 = 4.$ Determine I_{REF}, I_O and $V_{SD2}(\text{sat})$.



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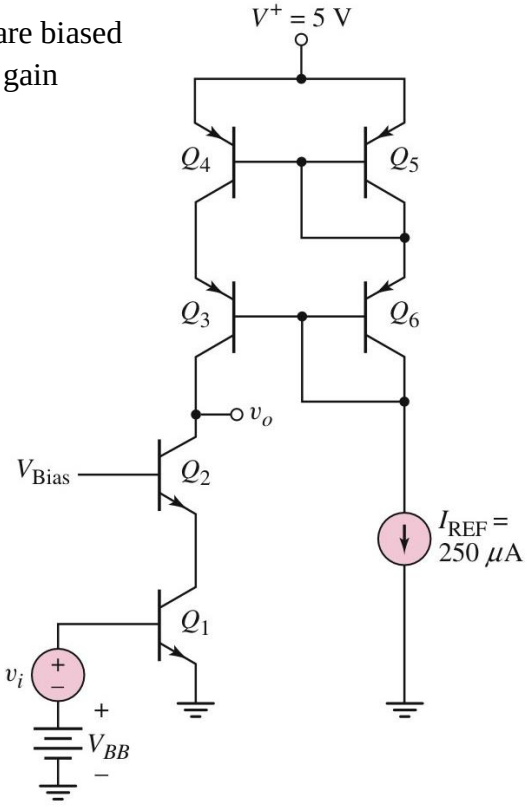
4. (25%) Assume transistor parameters are $\beta = 120$ and $V_A = 80V$. The V_{BB} voltage is such that all transistors are biased in the active region. Determine the small-signal voltage gain $A_v = v_o / v_i$.



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