Homework Assignment No. 12

Due Friday, April 11, 2003 in class

Problem 1 - (10 points)

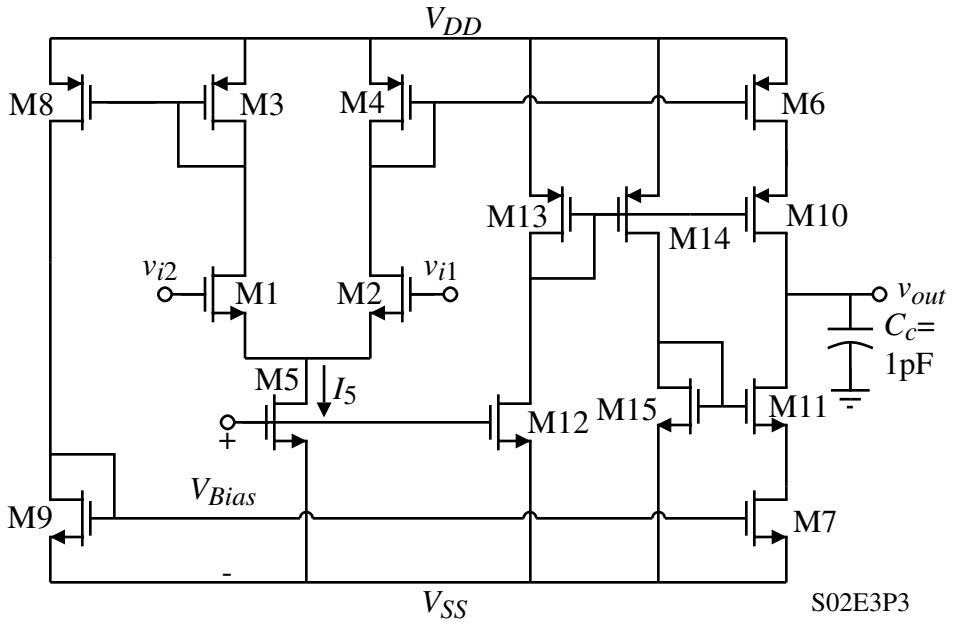
Problem 7.3-7 of Allen and Holberg, 2nd edition

Problem 2 – (10 points)

Calculate the small-signal voltage gain, the *SR* (C_L = 1pF), and the P_{diss} for the op amp shown where I_5 = 100nA and all transistors M1-M11 have a *W/L* of 10μm/1μm and V_{DD} = $-V_{SS}$ = 1.5V. If the minimum voltage across the drain-source of M6 and M7 are to be 0.1V, design the *W/L* ratios of M12-M15 that give the maximum plus and minus output voltage swing assuming that transistors M12 and M15 have a current of 50nA. The transistors are working in weak inversion and are modeled by the large signal model of

$$i_D = \frac{W}{L} I_{DO} \exp\left(\frac{v_{GS}}{n V_t}\right)$$

where I_{DO} = 2nA for PMOS and NMOS and n_P = 2.5 and n_N = 1.5. Assume V_t = 26mV and λ_N=0.4V^{-1} and λ_P=0.5V^{-1}.



Problem 3 – (10 points)

Problem 7.4-3 of Allen and Holberg, 2nd edition

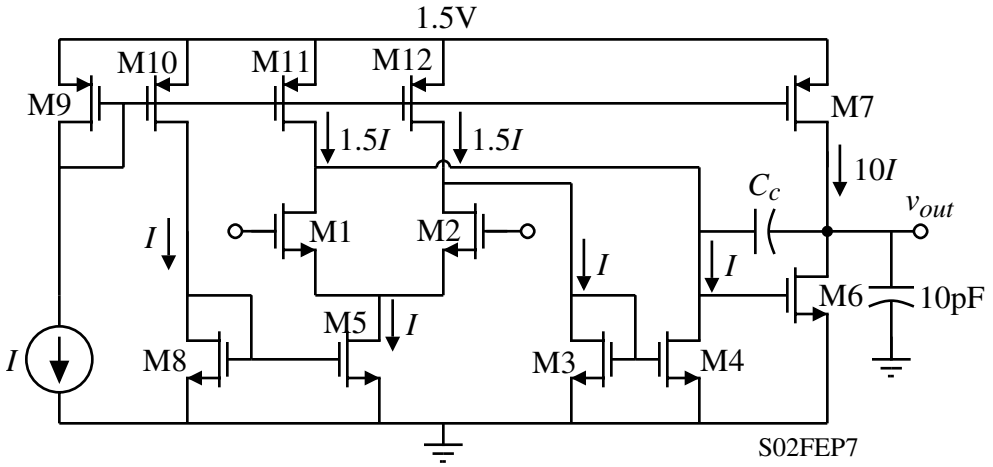
Problem 4 - (10 points)

Problem 7.5-5 of Allen and Holberg, 2nd edition

Problem 5 - (10 points)

A CMOS op amp capable of operating from 1.5V power supply is shown. All device lengths are 1μm and are to operate in the saturation region. Design all of the W values of every transistor of this op amp to meet the following specifications.

Slew rate = ±10V/μs	V_{out}(max) = 1.25V	V_{out}(min) = 0.75V
V_{ic}(min) = 1V	V_{ic}(max) = 2V	GB = 10MHz
Phase margin = 60° when the output pole = 2GB and the RHP zero = 10GB. Keep the mirror pole ≥ 10GB (C_{ox} = 0.5fF/μm^2).		



Your design should meet or exceed these specifications. Ignore bulk effects in this problem and summarize your W values to the nearest micron, the value of C_c(pF), and I(μA) in the following table. Use the following model parameters: K_N'=24μA/V^2, K_P' = 8μA/V^2, V_{TN} = - V_{TP} = 0.75V, λ_N = 0.01V^{-1} and λ_P = 0.02V^{-1}.

C_c	I	$W1$=$W2$	$W3$ = $W4$	$W5$ = $W8$	$W6$	$W7$	$W9$ = $W10$	$W11$ = $W12$	P_{diss}