PROBLEM SET #9

Issued: Tuesday, April 7, 2009

Due: Tuesday, April 14, 2009, **5:00 p.m.** in the EE 140 homework box in 240 Cory

1. An amplifier has low-frequency forward gain of 40,000, and its transfer function has three negative real poles with magnitudes 2 kHz, 200 kHz, and 4 MHz.

(a) If this amplifier is connected in a feedback loop with a constant feedback factor f and with low-frequency gain A_0=400, estimate the phase margin;

(b) Repeat (a) if A_0=200 and then 100.

2. The amplifier $a(s)$ is has DC gain of 10,000 and three real negative poles. The pole frequencies of the first and the third pole are 1 kHz and 200 MHz, respectively.

(a) If R_1=R_2 find the location of the second pole such that the feedback amplifier shown in Figure PS9-2 is stable with a phase margin of 60°. Neglect the input impedance of the amplifier.

(b) Write the transfer function in as a function of the complex variable s and draw Bode plots for the open-loop amplifier gain $a(s)$ and the closed-loop gain $A(s)$.

(c) What is the new phase margin if:

i. In addition to the three poles the amplifier $a(s)$ has one real right half-plane zero at the frequency of the second pole.

ii. In addition to the three poles the amplifier $a(s)$ has one real left half-plane zero at the frequency of the second pole.

iii. The closed-loop amplifier $A(s)$ is configured as a unity gain buffer.

iv. R_1=9R_2.

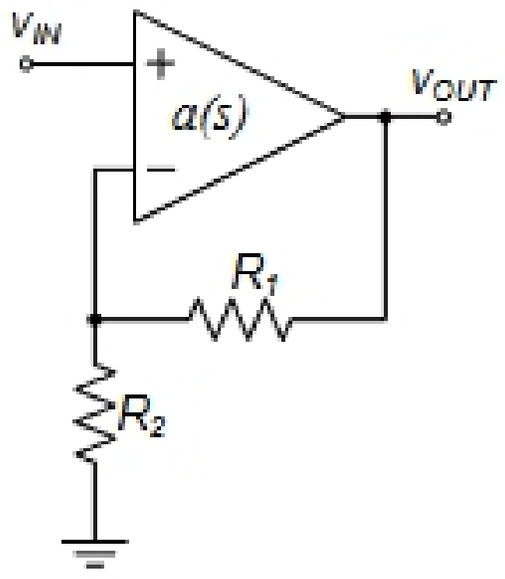

Figure PS9-2

3. Razavi, Chapter 10: Problem 10.4.

4. In the amplifier shown in Figure PS9-4 transistors M_3-M_8 are biased with V_{ov}=200mV. The gates of M_3 and M_4 are biased to allow the maximum undistorted sinusoidal signal at the output. Calculate all currents, channel widths and the value of capacitor C_c so that the amplifier has a DC gain of 20, a unity gain frequency of 50MHz, and a phase margin of 60° when placed in unity gain closed-loop feedback. All transistors have the same channel length. Neglect all parasitic capacitances in this problem.

$$V_{DD} = 3V,\ R_L = 10k\Omega,\ C_L = 5pF$$

$$V_{tk0,n} = 0.5V,\ \mu_n C_{ox} = 250\frac{\mu A}{V^2},\ L = 0.5\mu m,\ \lambda = 0,\ \ \gamma = 0,\ L_d = 0$$

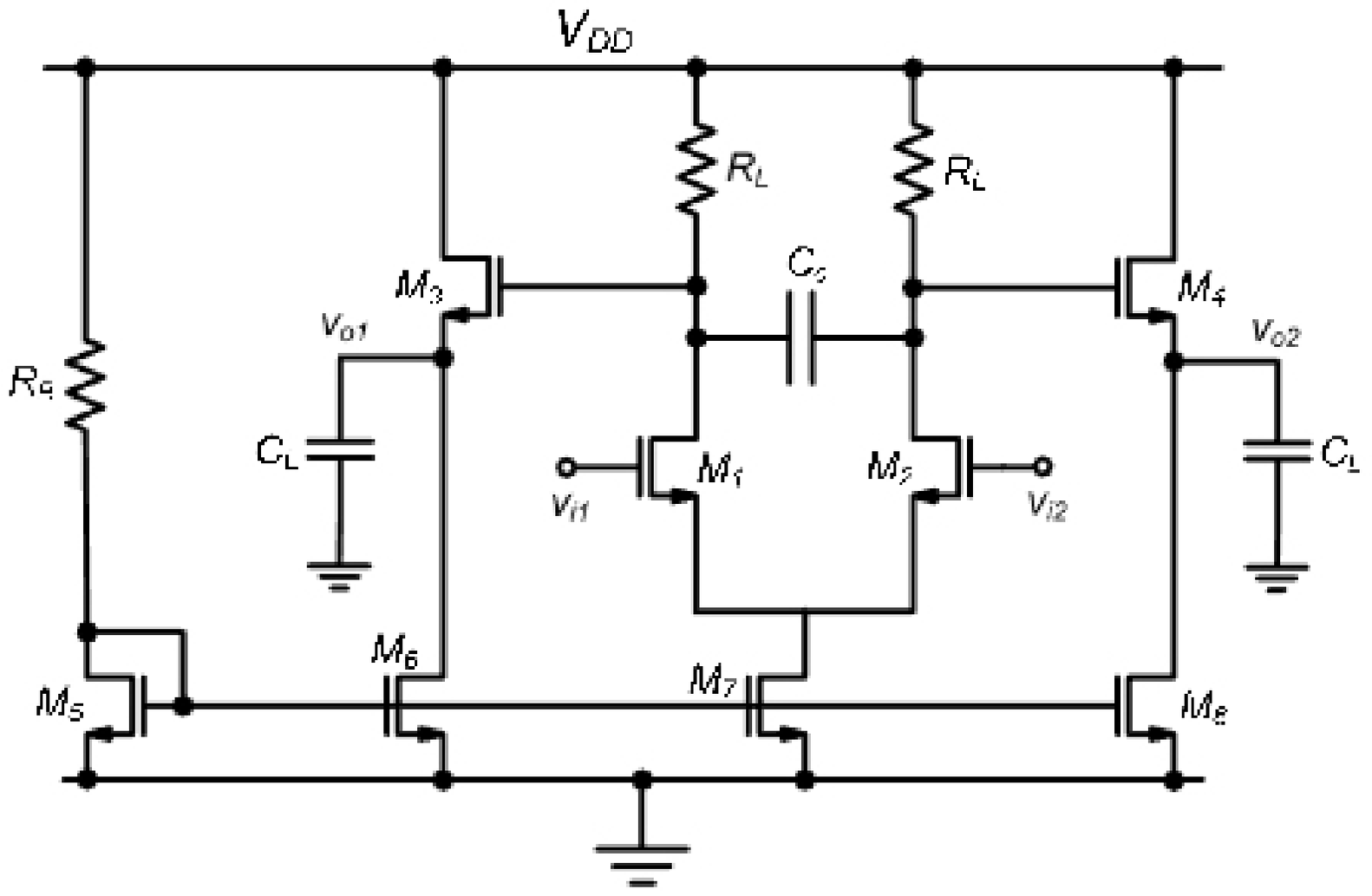

Figure PS9-4