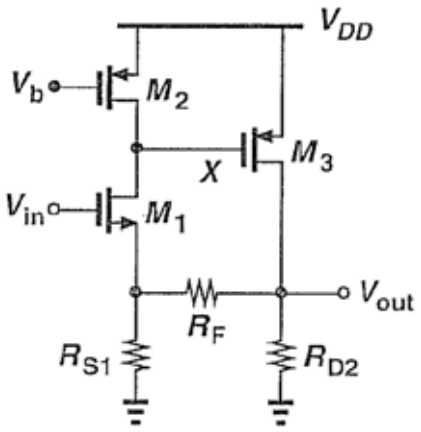
American University of Beirut
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING
EECE 311 – Electronic Circuits (Sections 1 & 2)
Spring 2008

HOMEWORK 5
Due Wednesday May 7, 2008 at 1:00 PM

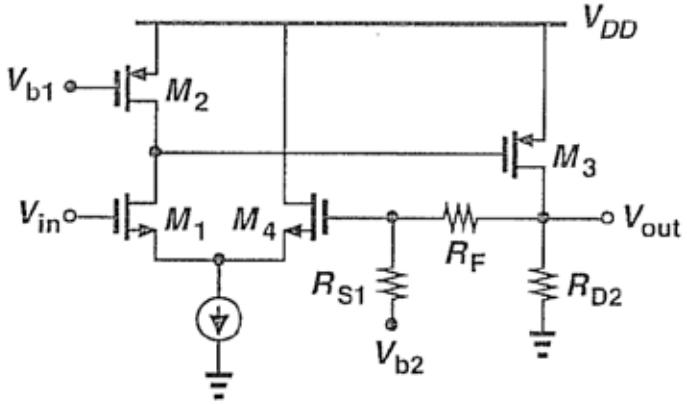
Problem 1.

In the circuit shown below, the (W/L) ratio for all MOSFETs is 50/0.5, and the drain currents are all 0.5 mA. The resistors are equal to 3 KΩ.
Assume V_{DD} = 3 V, k'_n = 180 μA/V^2, k'_p = 65 μA/V^2, V_{TN} = 0.65 V, V_{TP} = – 0.75 V, λ_N = 0.15 V^{-1} and λ_P = 0.2 V^{-1}.



(a) Determine the input bias voltage required to establish the above currents.
(b) Determine the type of feedback, and verify that the feedback is negative.
(c) Use the feedback analysis techniques to calculate:
    i. The closed-loop voltage gain
    ii. The output resistance

The circuit is now modified as shown below, where the MOSFET M_4 is inserted in the feedback loop. Note that M_1 and M_4 can also be viewed as a differential pair. Assume (W/L) = 50/0.5, all drain currents are 0.5 mA, and V_{b2} = 1.5 V.



(d) Using feedback analysis techniques, calculate the following quantities and compare with the results of part (c):

i. The closed-loop voltage gain

ii. The output resistance

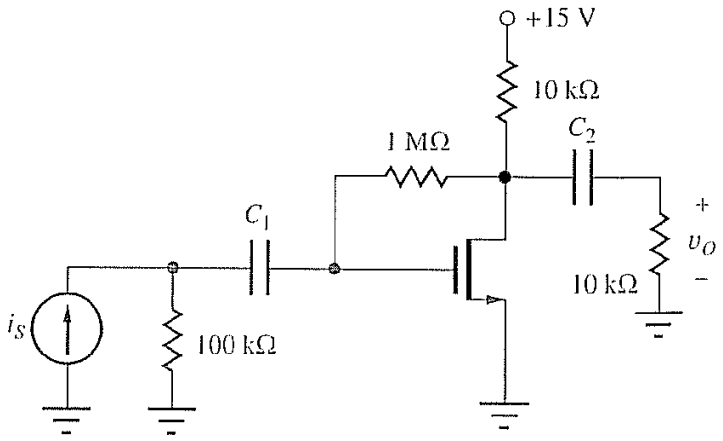
(e) Verify the results of parts (c) and (d) using PSpice.

Problem 2.

(a) In the circuit shown below, determine the type of feedback, and verify that it is negative.

(b) Using feedback analysis techniques, determine the gain, input resistance, and output resistance of the amplifier shown below. All capacitors are very large and have negligible impedance at the frequencies of interest.

Assume that for the MOSFET: g_m = 1.8 mA/V and r_o = 45 KΩ.



(c) Verify the results of part (b) using PSpice.

Problem 3.

The circuit shown below is a phase-shift oscillator. Assume that the op-amp is ideal.

(a) Find the frequency of oscillation.

(b) If the circuit oscillates at 8 KHz, find the capacitance value and the value of R_f, if R = 10 KΩ.