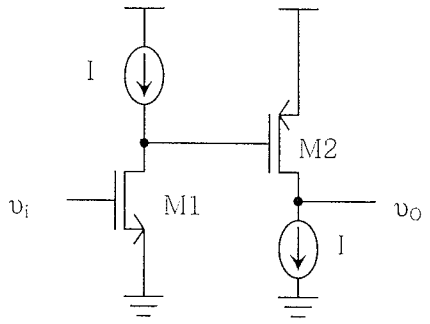
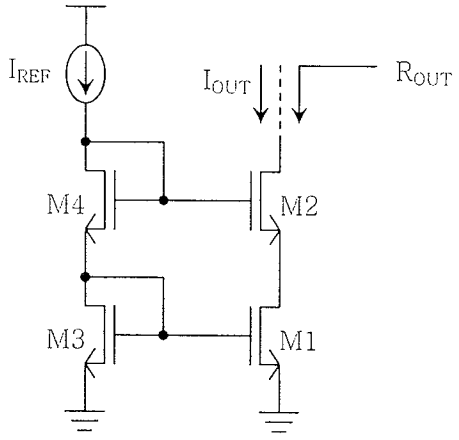
PLEASE USE EXAM BOOKLET
TO ANSWER QUESTIONS

Problem 1 [35 points: Gain Analysis] Consider a MOS amplifier formed by cascading tow common-source stages. Assuming the biasing current sources have very high output resistance, find an expression for the overall low frequency voltage gain (υ_O/υ_i) in terms of g_m and r_O of M1 and M2.



g_{m1} = Transconductance of M1
g_{m2} = Transconductance of M2
r_{O1} = Output resistance of M1
r_{O2} = Output resistance of M2

Problem 2 [35 points: Biasing] Find an expression for the output resistance (R_{OUT}) of the current mirror shown below in terms of g_m and r_O of M1 and M2. To simplify matters, assume that the incremental voltage at the gates of M1 and M2 is zero. (Hint: You can consider the nodes connected to the gates of M1 and M2 as analog ground.)

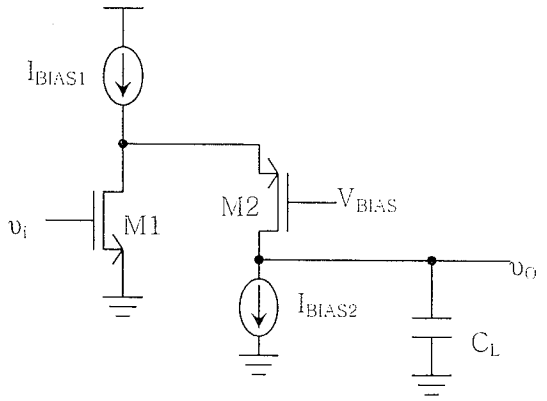


g_{m1} = Transconductance of M1
g_{m2} = Transconductance of M2
r_{O1} = Output resistance of M1
r_{O2} = Output resistance of M2

Problem 3 [30 points: Cascode Amplifier] The figure shows the circuit of a "folded cascode" amplifier. The circuit avoids transistor stacking characteristic of the cascode configuration and thus provide increased output swing capability.

Assume M1 and M2 have equal g_m and r_O.

Assume the current sources I_{BIAS1} and I_{BIAS2} have infinite output resistance.



g_m = Transconductance of M1 and M2

r_O = Output resistance of M1 and M2

(a) (15 points) Find an expression for the low frequency voltage gain (υ_O/υ_i) in terms of g_m and r_O.

(b) (15 points) The dominant high-frequency pole is usually formed at the output node. If the total capacitance at that node is C_L, find an expression for the pole frequency (ω_H) in terms of C_L, g_m, and r_O.