Department of Electrical and Computer Engineering, Cornell University

ECE 3150: Microelectronics

Spring 2016

Homework 11 **Due on April 28, 2016 at 7:00 PM**

Suggested Readings:

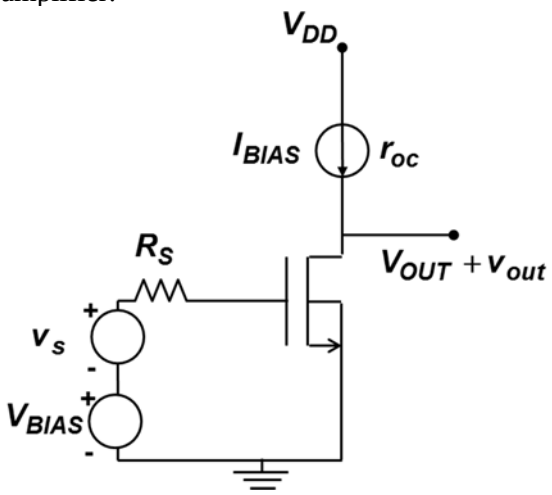
a) Lecture notes

Important Notes:

1) MAKE SURE THAT YOU INDICATE THE UNITS ASSOCIATED WITH YOUR NUMERICAL ANSWERS. OTHERWISE NO POINTS WILL BE AWARDED.
2) Unless noted otherwise, always assume room temperature.

Problem 11.1: (Frequency performance of amplifier stages using open circuit time constants technique)

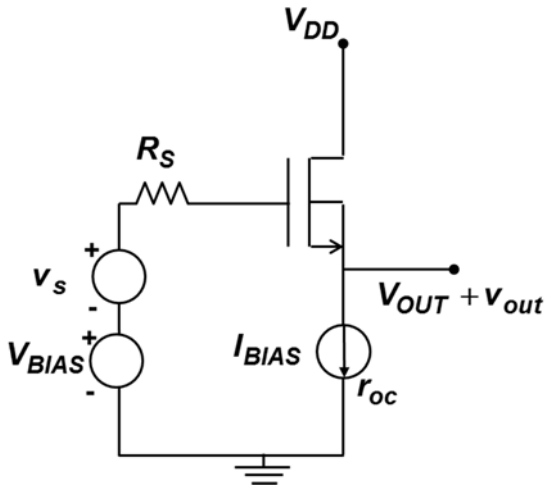
Consider the following CS amplifier:



a) Find all the time constants associated with all the capacitors in the small signal circuit model using the open circuit time constant technique.

b) Find an approximate expression for the roll-over frequency ω_H associated with the amplifier voltage gain $A_V(\omega)$. Does the CS stage suffer from the Miller effect?

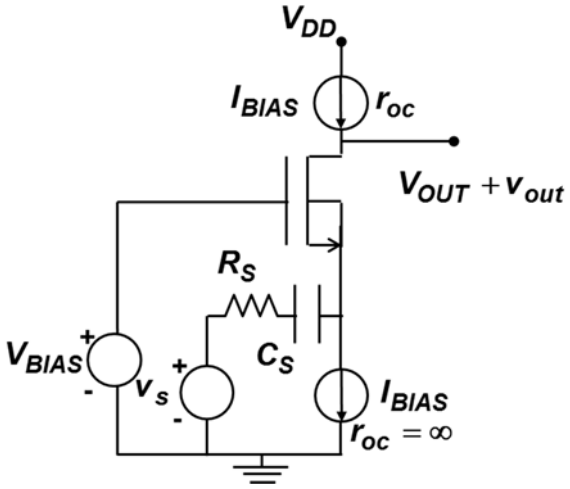
Now consider the following CD amplifier:



c) Find all the time constants associated with all the capacitors in the small signal circuit model using the open circuit time constant technique.

d) Find an approximate expression for the roll-over frequency ω_H associated with the amplifier voltage gain $A_v(\omega)$. Does the CD stage suffer from the Miller effect?

Now consider the following CG amplifier:

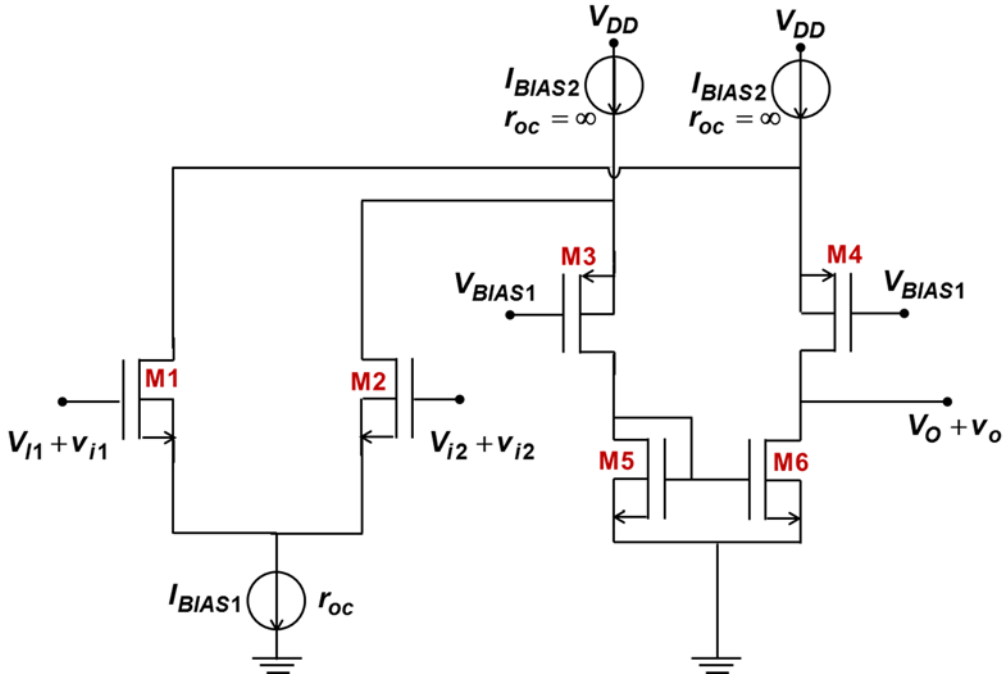


e) Find all the time constants associated with all the capacitors in the small signal circuit model using the open circuit time constant technique. NOTE: you may assume that the lower current source used for biasing has infinite output resistance and the capacitor C_S is an AC short at the frequencies of interest so you can replace it by a short in the small signal model.

f) Find an approximate expression for the roll-over frequency ω_H associated with the amplifier voltage gain $A_v(\omega)$. Does the CG stage suffer from the Miller effect?

Problem 11.2: (Folded Cascode Differential Amplifier)

Consider the following folded cascode differential amplifier:



The FETs M1 and M2, M3 and M4, and M5 and M6 are matched pairs. The output resistances of sources I_{BIAS2} are assumed to be infinity (for convenience). Assume appropriate DC biasing such that the currents in the two legs of the first stage are identical, and the currents in the two legs of the second stage are also identical.

a) Find the differential mode gain A_{vd} of the amplifier assuming a differential small signal input.

b) Find the short circuit output current (i.e. current flowing in the output when the output is shorted to the ground) assuming a differential small signal input.

c) Find the output resistance of the amplifier.