University of California at Berkeley
College of Engineering
Dept. of Electrical Engineering and Computer Sciences

EE 105 Midterm 2

Spring 2007   Prof. Ming C. Wu   April 5, 2007


Guidelines

- Open book and notes.
- The values of common parameters are listed at the beginning of next page.

(1) Consider the following amplifier. The small-signal parameters for the transistor M1 are: $g_m = 0.1$ mS, $r_o = 100$ kΩ, $R_s = 1$ kΩ, $R_L = 100$ kΩ, $C_{GD} = 10$ fF, $C_{GS} = 100$ fF, $C_{DB} = C_{SB} = 10$ fF.

   a) [10 pt] What is the small-signal voltage gain of the amplifier?

   b) [5 pt] Draw the circuit with all parasitic capacitances. Reduce the diagram to minimum number of capacitances.

   c) [10 pt] How many poles are there? Find all the pole frequencies.

   d) [5 pt] What is the 3-dB frequency of this amplifier (in Hz)?
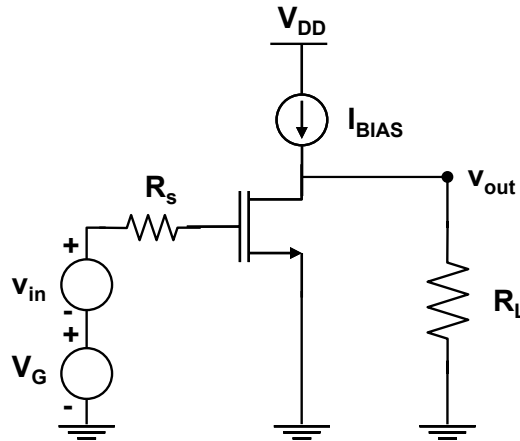
(2) The following is a two-stage amplifier. Use the following parameters for this problem: $\mu_n C_{ox} = 100$ μA/V^2, $\mu_p C_{ox} = 50$ μA/V^2, $(W/L)_1 = 10$, $(W/L)_2 = 20$, $(W/L)_3 = 40$, $(W/L)_4 = 20$, $V_G = 1$V. The threshold voltages are $V_{TH} = 0.4$ V for NMOS and -0.4V for PMOS. Ignore channel length modulation.

   a) [15 pt] Find the DC voltage of the output node, V_{OUT} (*Hint: Find the DC voltage at Node X first*)

   b) [15 pt] Find the <u>expression</u> and the <u>numerical value</u> of the total voltage gain.
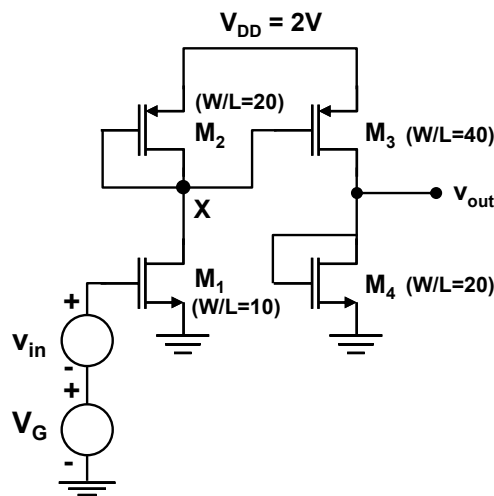
(3) Consider the following circuit. Use the following parameters for this problem: $\mu_n C_{ox}$ = 100 μA/V^2, $\mu_p C_{ox}$ = 50 μA/V^2, $\lambda_n = \lambda_p = 0.1$ V^{-1}, $R_S = 100\Omega$. The (W/L) values of the MOS transistors are marked in the diagram.

   a) [10 pt] What is the function of the circuit? Which is the main amplifying transistor?
   b) [5 pt] What is the current going through M4-M5? What is the drain current going through M3-M1-M2?
   c) [5 pt] If we use a current source as input, and measure the output current, what is the small-signal current gain of this amplifier?
   d) [5 pt] Find the value of g_{m1}.
   e) [5 pt] What is the equivalent input circuit seen by the source, v_{in}? What is v_s / v_{in} ?
   f) [10 pt] What is the <u>expression</u> of the voltage gain of this amplifier? What is its numeric value?