Microelectronic Devices and Circuits- EECS105

Second Midterm Exam

Wendesday, November 17, 1999

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Department of Electrical Engineering and Computer Sciences

Your Name: ____
(last) *(first)*

Your Signature: ____

1. *Print and sign your name on this page before you start.*
2. *You are allowed two 8.5"x11" handwritten sheets with formulas. No books or notes!*
3. *Do everything on this exam, and make your methods as clear as possible.*

Problem 1 ________ / 30
Problem 2 ________ / 35
Problem 3 ________ / 35

TOTAL _______ / 100

Problem 1 of 3 Answer each question briefly and clearly. (30 points)

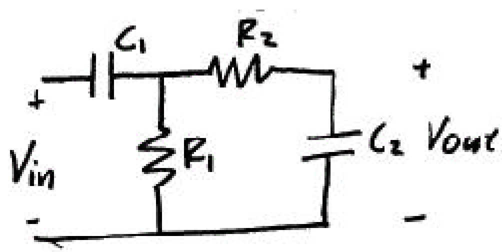
Explain briefly why BJT performance depends so much on the diffusivity of minority carriers (6pts)

How does the small signal output resistance of a BJT depend on its size (emitter-to-base junction area), when V_{BE} is held constant? (6pts)

Why is it desirable to have $V_{BS} = 0V$ in MOS Common Gate applications? (6pts)

What happens to the overall (loaded) $|A_v|$ when I_c increases in a CE amplifier? (Assume that R_L is initially equal to r_o, $R_s << r_\pi$ and r_{oc} = infinity)(6 pts)

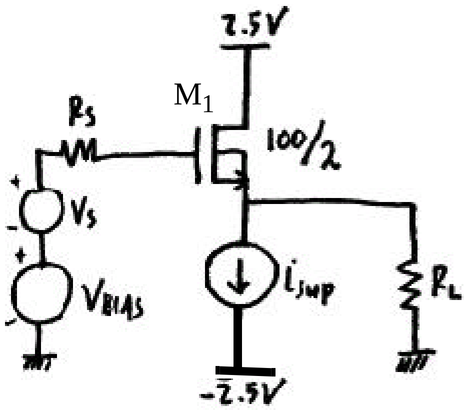
How many poles and how many zeros does this circuit have? What is its function, assuming that $R_1C_1 << R_2C_2$? (6pts)



Problem 2 of 3 (35 points)

For each of the following questions, make sure that you show the expressions <u>*before*</u> *you plug in the specific values. A correct expression is worth 70% of the credit, even if the numerical calculation is incorrect!*

<u>You are given the following nmos common drain amplifier.</u>

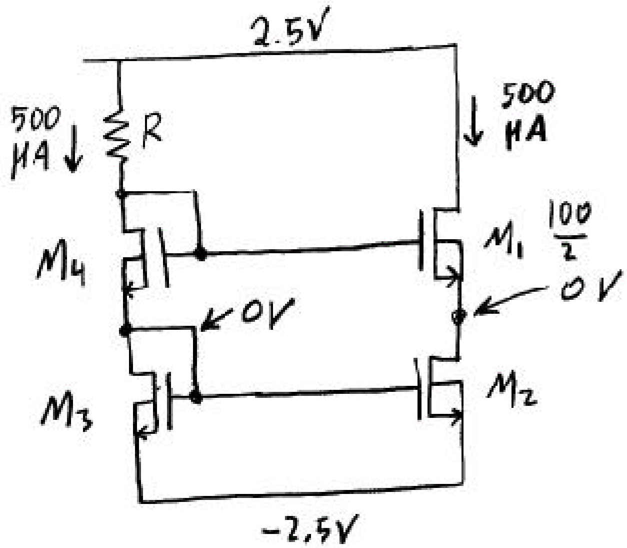


W/L = 100/2
V_{Tn} = 0.7V
$\mu nCox=50\mu A/V^2$
$\lambda_n=0.05V^{-1}$ (for L=2μm
$r_{oc}=r_o$
R_L = 10K

a) Assume V_{bs}=0v, and find V_{bias} so that I_{sup} = 500μA. (12pts)

b) Calculate the overall (loaded) voltage gain, with V_{bs}=0V. (10pts)

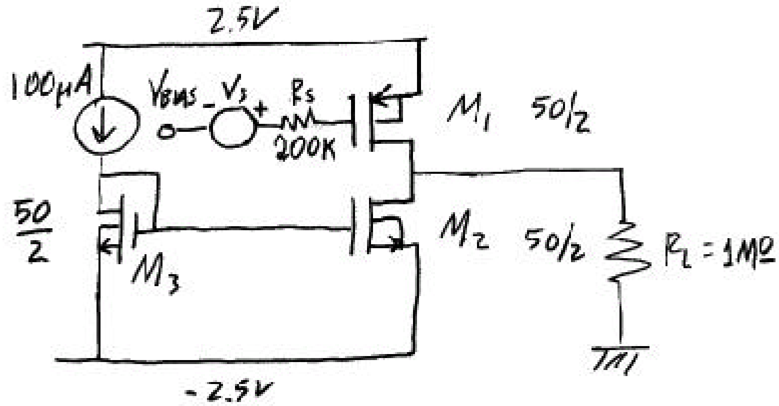
c) You are now going to design the biasing circuit for this amplifier. Assuming that the size of M_4 is the same as M_1 (100/2), size the biasing transistors M_2, M_3, and resistor R in order to get the proper supply current through the common drain amplifier transistor M_1. Note that the voltage at the drains of M_3 and M_2 is 0V. (13pts)



Problem 3 of 3 (35 points)

For each of the following questions, make sure that you show the expressions <u>*before*</u> *you plug in the specific values. A correct expression is worth 70% of the credit, even if the numerical calculation is incorrect!*

You are given the following p-channel common-source amplifier.



$W/L = 100/2$
$V_{Tn} = 0.7V$
$\mu nCox = 50\mu A/V^2$
$\lambda_n = 0.05V^{-1}$ (for $L = 2\mu m$)
$r_{oc} = r_o$
$R_L = 1M\Omega$
$R_s = 200K\Omega$

a) Draw the small signal model of the amplifier. Make sure that you include the entire small signal model of the CS amplifier transistor M_1, along with all the relevant capacitances, including r_{o2}, C_{db2} and C_{gd2} from the current sink transistor M_2. (10 points)

b) Apply the Miller approximation (ignore all capacitances when calculating the Miller gain), and derive a symbolic expression for the complete transfer function (hint: this function has two poles and no zeros) (7 points).

c) Calculate the dc gain and the values of the two poles, given that C_{gs1}=78fF, C_{gd1}=25fF, C_{gd2}=25fF, C_{db1}=90fF, C_{db2}=30fF (8 points)

d) Draw the Bode plot for amplitude and phase of the gain of this amplifier (10 points).