University of California at Berkeley

Microelectronic Devices and Circuits- EECS 105

Second Midterm Exam

Wednesday, November 15, 2000

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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. <u>You are allowed two 8.5"x11" handwritten sheets with formulas. No books or notes!</u>
3. Do everything on this exam, and make your methods as clear as possible.

Problem 1 _____ / 30

Problem 2 _____ / 40

Problem 3 _____ / 30

TOTAL _____ / 100

Problem 1 of 3 Answer each question briefly and clearly. Sketch a simple drawing if it helps you make your point. (30 points)

What is the physical mechanism limits the maximum f_T of a BJT? (6 pts)

What is "base-width modulation" and how does it affect the behavior of BJT? (6pts)

You are given a 2-port, which has $R_{in} = 1K\Omega$, $R_{out} = 100K\Omega$ and an open circuit voltage gain $A_V = -10$. Please draw the equivalent transconductance 2-port and calculate its R_{in}, R_{out}, and G_m. (6 pts)

consider a CE amplifier. What is (are) the benefit(s) of using an ideal current source versus a resistor connected to the supply to bias the collector? (6 pts)
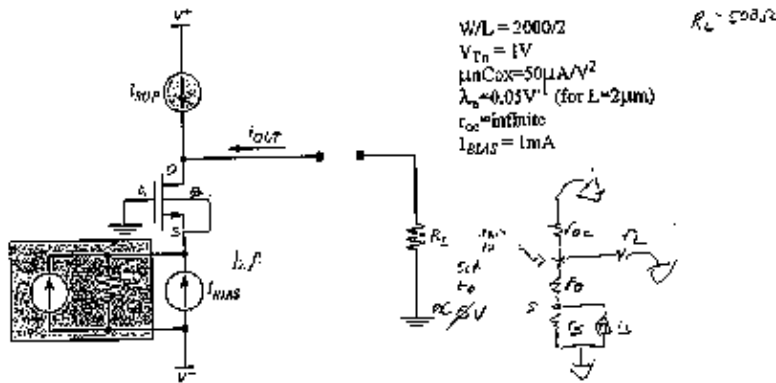
Sketch the small signal equivalent of the following amp (ignore all capacitors) (6 pts):
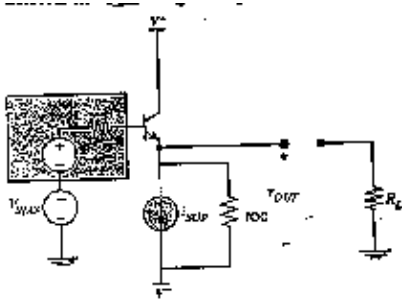
Problem 2 of 3 (40 points)

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

We want to "match" a car radio antenna to the radio input. The antenna acts as a small signal current source with an $R_s = 50\Omega$ The radio input "looks" like an ohmic load with $R_i = 500\ \Omega$ We will use the following CG MOS amplifier in order to achieve decent current gain from the signal source to the load. Note that the bulk is shorted to the source ($V_{bs} = 0V$). Ignore all caps in answering the following questions
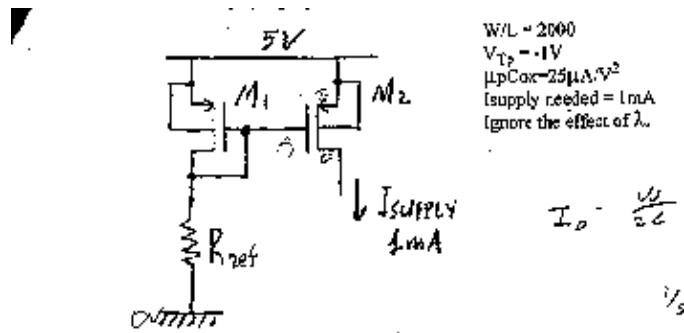

a) Draw the equivalent small signal circuit of this amplifier (10pts)

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a) draw the equivalent small signal circuit of this amplifier (10 pts)

b) Sketch the 2-port Current Amp equivalent, and write expressions for R_{in}, R_{out}, and A_i. Assume that $r_o \gg R_s$ and $r_o \gg R_L$. (10 pts).

c) Calculate the overall (loaded) current gain, (note that $V_{bs} = 0$ V). (10pts)

M1 and M2 have both the same W/L. Find the value of R_{ref} so that this current source delivers the 1 mA of supply current that is needed (for this part of the problem assume that the load draws no DC current). (10pts).

W/L ~ 2000
$V_{T_p} = -1V$
$\mu pCox = 25\mu A/V^2$
Isupply needed = 1mA
Ignore the effect of λ.

$I_D = \frac{W}{2L}$

$1/s$

Problem 3 of 3 (30 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!

a) Derive the transfer function Vout/Vin expression of the following amplifier (10 pts).
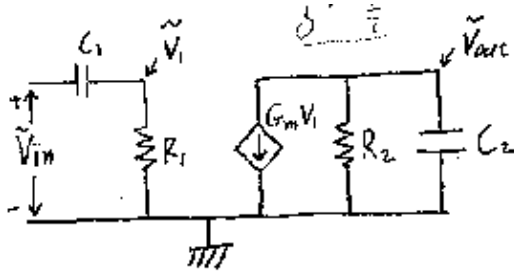
b) Plot amplitude and phase Bode plots when R_1 = 10KΩ C_1= 0.01 H, R_2 = 1KΩ C_2 = 0.001 H, G_m = 0.01 S. (10 pts for each plot).