Microelectronic Devices and Circuits- EECS105

Second Midterm Exam

Wednesday, November 15, 2000

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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 ________ */ 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)

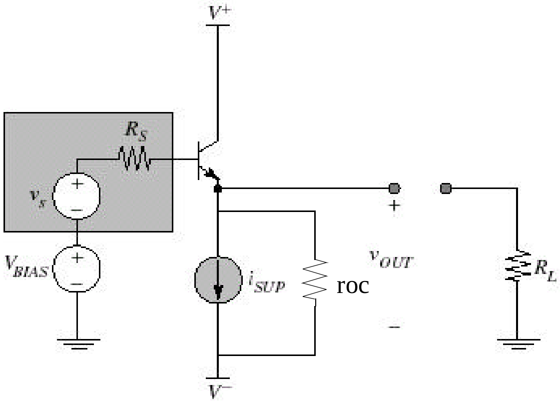
What physical mechanism limits the maximum f_T of a BJT? (6pts)

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}=1kΩ, R_{out}=100kΩ, and an open circuit voltage gain A_v = -10. Please draw the equivalent <u>transconductance</u> 2-port and calculate its R_{in}, R_{out}, and G_m. (6pts)

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)

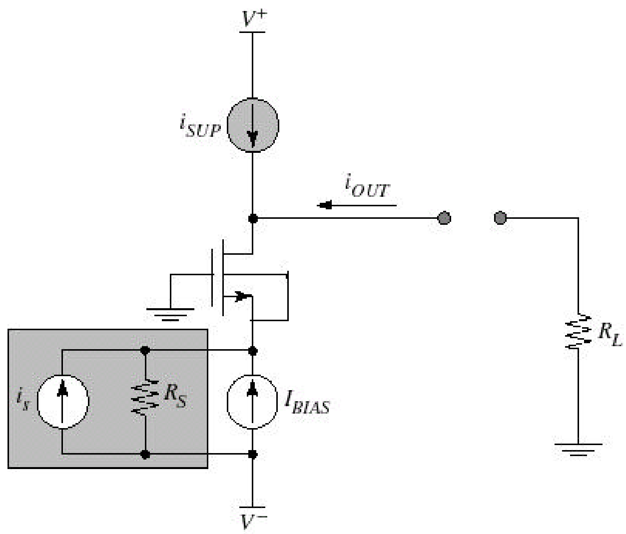
Sketch the small signal equivalent of the following amp (ignore all capacitors) (6 pts):



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 = 50Ω. The radio input "looks" like an ohmic load with R_L=500Ω. 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:



W/L = 2000/2
V_{Tn} = 1V
$\mu nCox=50\mu A/V^2$
$\lambda_n=0.05V^{-1}$ (for L=2μm)
r_{oc}=infinite
I_{BIAS} = 1mA

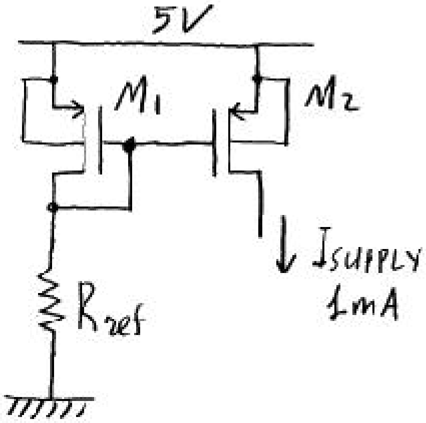
a) Draw the equivalent small signal circuit of this amplifier (10pts)

b) Sketch the 2-port Current Amp equivalent, and write expressions for R_{in}, R_{out} and $A_{i.}$ Assume that $r_o >> R_S$ and that $r_o >> R_L$. (10 pts).

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

d) You are now going to design part of the biasing circuit for this amplifier. The p-channel transistors

M_1 and M_2 have both the same W/L. Find the value of R_{ref} so that this current source delivers the 1mA of supply current that is needed (for this part of the problem assume that the load draws no DC current). (10pts).

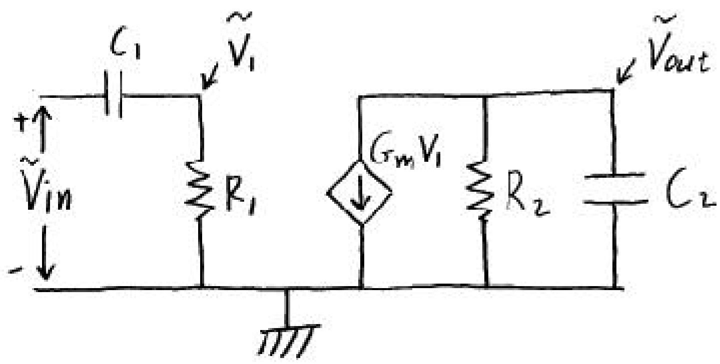


W/L = 2000
V_{Tp} = -1V
$\mu pCox=25\mu A/V^2$
Isupply needed = 1mA
Ignore the effect of λ.

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 **V**out/**V**in expression of the following amplifier (10 pts).



b) Plot amplitude and phase Bode plots when R_1=10kΩ, C_1= 0.01μF, R_2=1kΩ, C_2=0.001μF, G_m=0.01S. (10 pts for each plot).