EE 105, Fall 1992
Midterm #2
professor Howe

Closed book and notes; one formula sheet(both sides)
Do all work on exam pages
You have 50 min; use your time wisely

Problem #1

Bipolar Amplifier

Given: npn: $ß_n$=100, Early voltage V_{A_n}=100V

pnp: $ß_p$=20, Early voltage V_{A_p}=50V

The voltage V_{IN} is adjusted so that the DC output voltage level V_{OUT}=0V.

The resistances roc of the current sources are infinite. The various small-signal resistances referred to in parts(b)-(d) are defined on the schematic.

If you do not have time to find numerical values, leave the answer in symbolic form-be sure to include subscripts to identify which transistor the parameter is for.

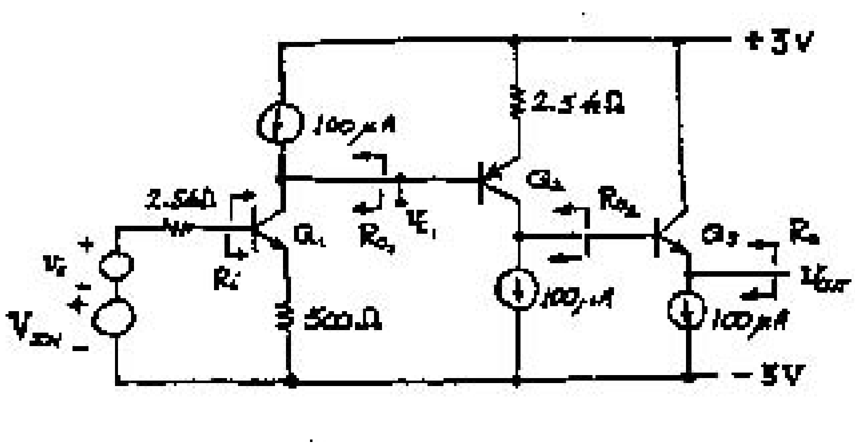
(a) (3 pts) Find the DC values of V_{CE_1}, V_{EC_2}, and V_{CE_3}. You can neglect base currents.

(b) (3 pts) Find the numerical value of the input resistance Ri.

(c) (4 pts) Find the numerical value of the output resistance of the first stage, Ro1.

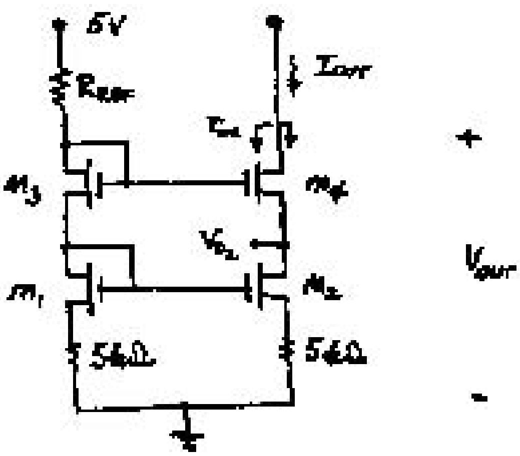
(d) (4 pts) Find the numerical value of the output resistance Ro. Given: the output resistance of the second stage is Ro2=500KOhm.

(e) (4 pts) Find the numerical value of the small-signal voltage gain A1 between the voltage source vs and the collector of Q1: A1=vc1/vs



Problem #2

(18 points) fancy MOS current source



Given for all transistors: (W/L)=32, mobility*Cox=100microA/V^2, VTn=1V, lambdan=0.01.

(a) (5 pts) Find the numerical value of R(REF) such that the output current is IOUT=100 microA

(b) (3 pts) Find the numerical value of the drain voltage of transistor M2, VD3. If you could not solve part(a), assume that R(REF)=25KOhm, which is (of course) not the correct answer to part(a).

(c) (5 pts) What is the minimum value of the output voltage VOUT for which all transistors are saturated?

(d) (5 pts) Find the numerical value of the output resistance roc of the current source. Given: gm*ro=800 for all transistors.

Problem #3

Given: base-emitter junction is forward biased, base-collector junction is reverse biased, the base transport factor alpha(T)=1 (meaning that no recombination occurs in the base).

Given: Dn=20cm^2/s, Dp=10cm^2/s. The area of the base-emitter junction is: AE=10^(-5)cm^2.

(a) (3 pts) What is the numberical value of the electron diffusion current density in the base(units: A/cm^2)

(b) (3 pts) What is the numberical value of the hole diffusion current density in the emitter (units: A/cm^2)

(c) (4 pts) What is the numberical value of the collector current IC?

(d) (4 pts) What is the numberical value of the current gain?