

**Final Exam, ECE 137A**

**Wednesday March 21, 2001**

**8-11 AM**

Closed Book Exam.

Class Crib-Sheet and 2 pages (4 surfaces) of student notes permitted

Do not open this exam until instructed to do so.

Use any and all reasonable approximations, *after stating them*.

Please write your final numerical answers in the spaces indicated.

***Show your work: Full credit will not be given for correct answers if supporting work is missing.***

There are xx problems, and you have xx hours.

Name: \_\_\_\_\_



Part 1, 5 points

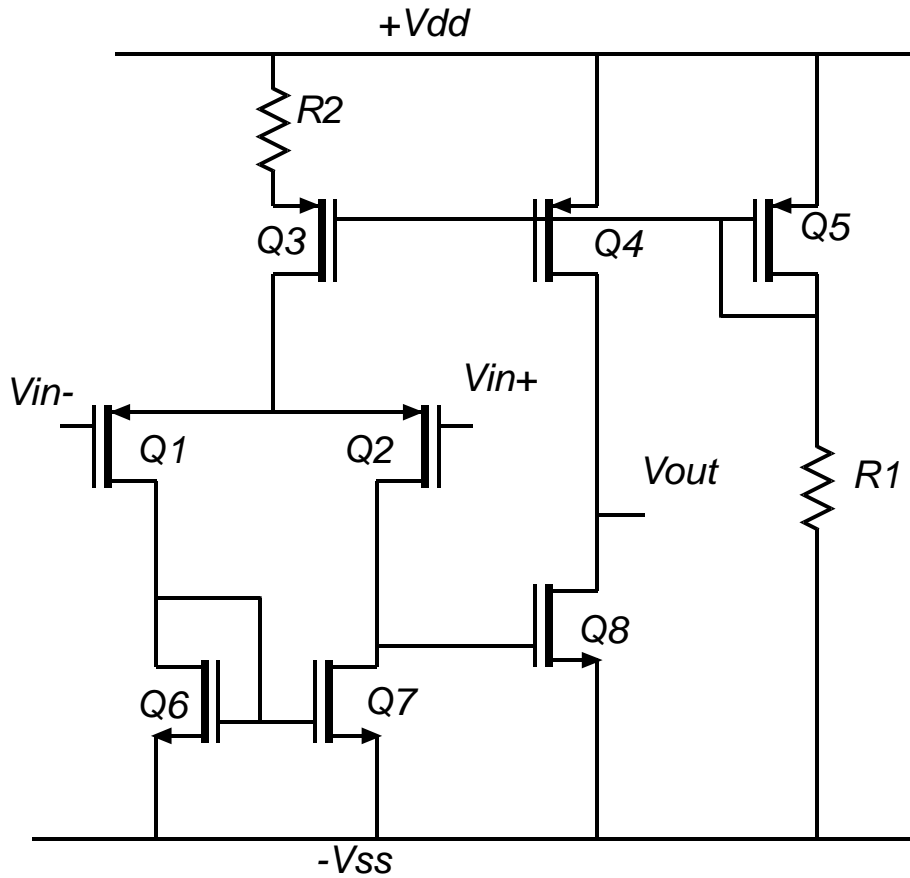
Q1 and Q2 are to be biased at 100 microamps drain current. Q4 is to be biased at 1 mA drain current. Find R1 and R2

R1=\_\_\_\_\_ R2=\_\_\_\_\_

Part 2, 7 points

The circuit is an op-amp, work bias conditions from the assumption of  $V_{out}=0$  Volts  
Draw on this diagram

- 1) the drain current in each transistor (1/2 pt each)
  - 2) the voltage at each node ( $V_{in-}$  and  $V_{in+}$  being at 0 V bias) (1/2 pt each)
- Hint: for the DC bias calculation ONLY, ignore the effect of lambda.



Part 3, 7 points

Find the small signal gain of Q8

$A_v =$  \_\_\_\_\_

Part 4 10 points

Find the small signal gain of the differential pair Q1/Q2

$A_v =$  \_\_\_\_\_

Part 5 , 1 point

Find  $V_{out}/V_d$  for the total amplifier

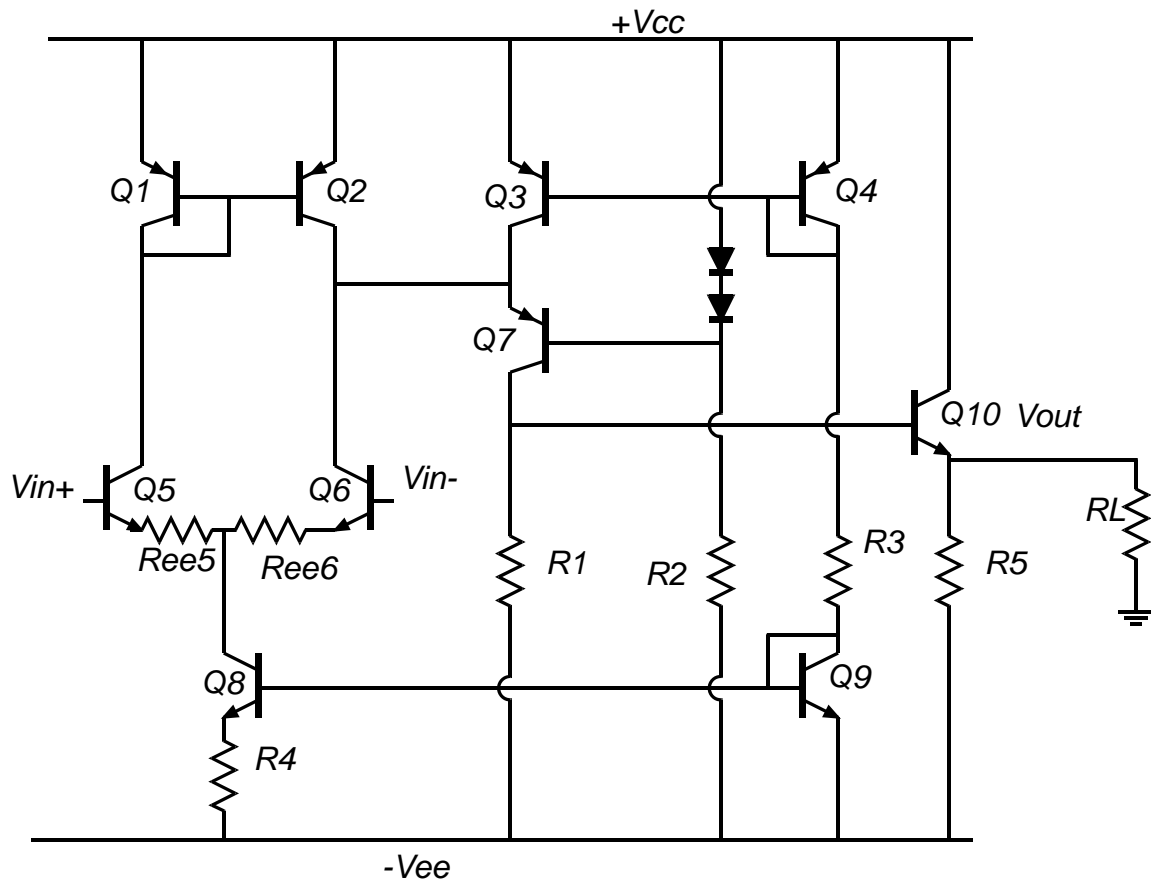
$V_{out}/V_d =$  \_\_\_\_\_

Part 6, 10 points

Find the maximum undistorted peak-peak output voltage.

Vout, peak-peak, max = \_\_\_\_\_

**Problem 2 60 points**



All transistors have  $\beta = 200$  and  $V_a = 150$  Volts.

All transistors have Identical  $I_s$  (are matched)

$V_{cc} = 10$  Volts,  $-V_{ee} = -10$  Volts

$R_L = 1$  kOhm

\*\*\*\*\* **This is NOT an op-amp** \*\*\*\*\*.

DC bias is to be analyzed assuming  $V_{in+} = V_{in-} =$  zero volts,

Part 1 7 points

Q5 and Q6 are to be biased at 0.1 mA collector current.

Q7 is to be biased at 1 mA collector current.

Q10 is to be biased at 10 mA collector current

R2=18.6 kOhm

Vout is to be zero volts DC.

Ree5=Ree6=100 Ohms

Find the resistor values:

R1=\_\_\_\_\_

R4=\_\_\_\_\_

R4=\_\_\_\_\_

R5=\_\_\_\_\_

R6=\_\_\_\_\_



Part 3, 10 points

Find the voltage gain and input impedance of Q10

$A_v =$  \_\_\_\_\_       $R_{in} =$  \_\_\_\_\_

Part 4, 10 points

Find the voltage gain and the input impedance of Q7

$A_v =$  \_\_\_\_\_       $R_{in} =$  \_\_\_\_\_

Part 5, 12 points

Find the voltage gain and the input impedance of the differential pair

$A_v =$  \_\_\_\_\_       $R_{in} =$  \_\_\_\_\_

Part 6 1 points

Find  $V_{out}/V_{in}$  for the total amplifier

$V_{out}/V_{in} = \underline{\hspace{10em}}$

Part 7, 13 points

Find the maximum peak-peak undistorted output voltage.