ECE 137 A Mid-Term Exam

Thursday February 6, 2014

Do not open exam until instructed to.

Closed book: Crib sheet and 1 page personal notes permitted

There are 2 problems on this exam, and you have 75 minutes.

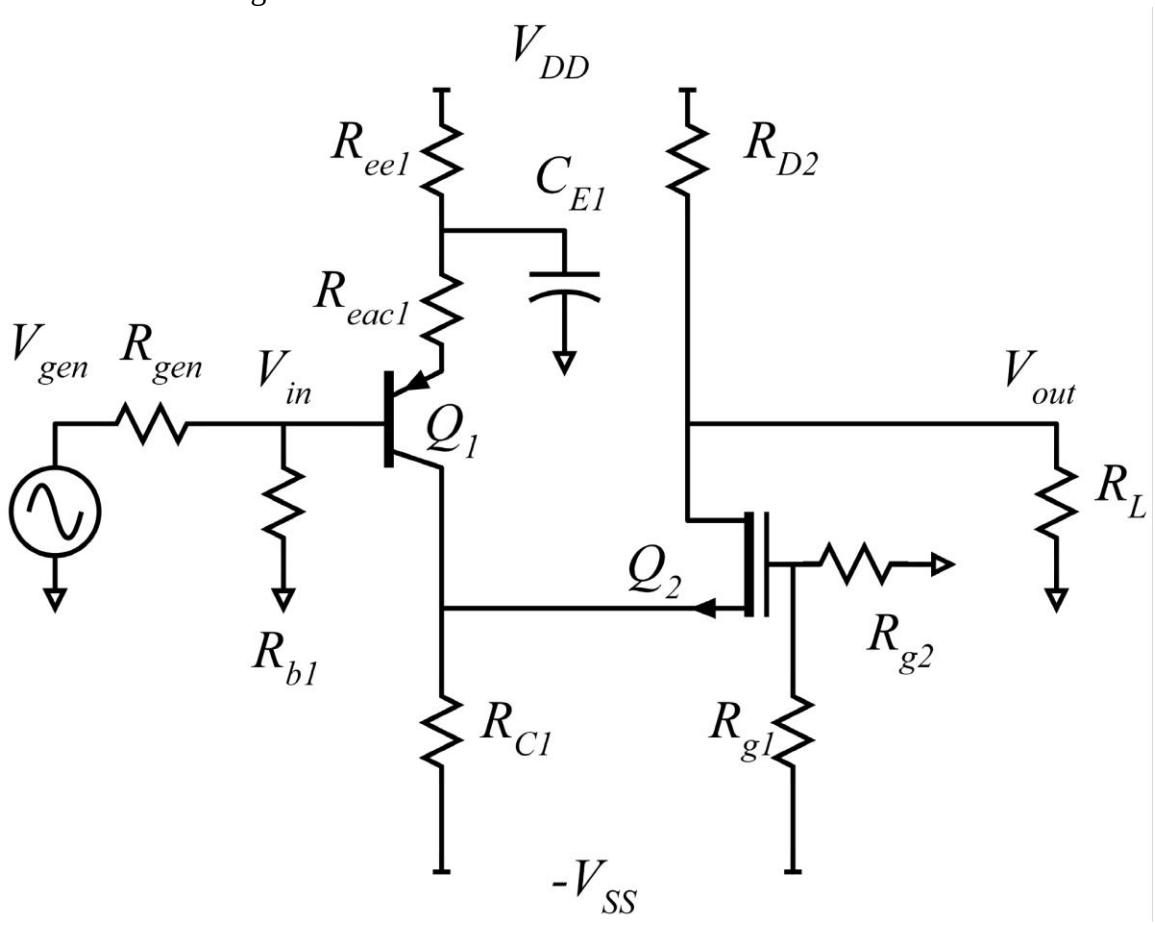
Use any and all reasonable approximations (5% accuracy is fine.) , ***AFTER STATING and approximately Justifying them.***

Name: _____

Part	Points Received	Points Possible
1a		7
1b		7
1c		6
1d		15
1e		15
1f		6
1g		14
2a		12
2b		13
2c		5
TOTAL		100

Problem 1, 70 points

You will be working on the circuit below:



Q1: $\beta = 100$, V_A =100 V

Q2: Velocity-limited $V_{th} = 0.2V$, $1/\lambda =$ infinity, $\Delta V = L_g v_{th} / \mu$ =0.1V, $c_{ox} v_{th} W_g$ =5mA/V

The supplies are +3V and -3 V

Rgen=1000 Ohms, RL=10,000 Ohms. Rg2=100kOhms, Reac1=74 Ohms, Rb1=10kOhms

Ce1 is very large (AC short-circuit)

Part a, 7 points

DC bias.

V_{in} is at (approxiately) zero volts DC.

The gate of Q2 is to be biased at -1.5 Volts

The drain is to be biased at zero volts.

Q1 is to be biased at 1 mA emitter current

Q2 is to be biased at 2 mA drain currrent.

Find the following:

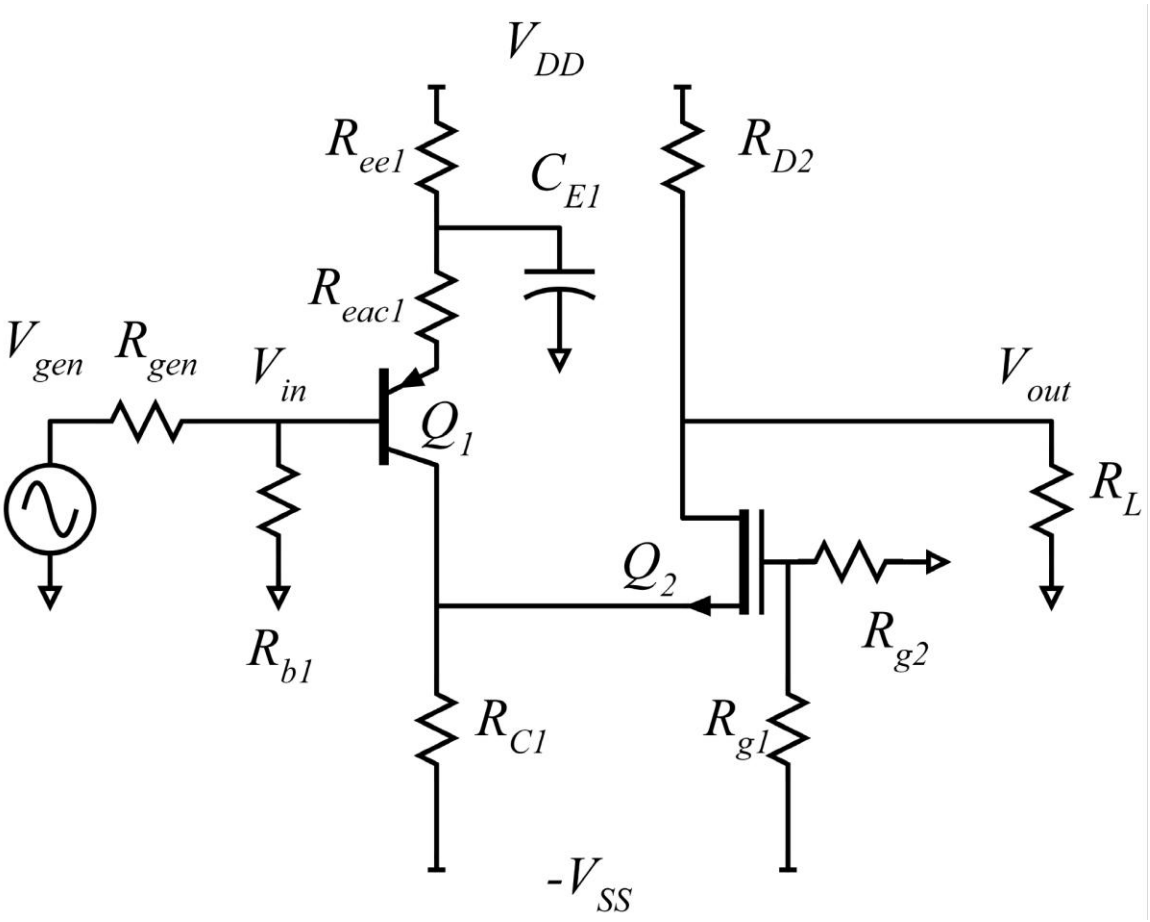
Rc1=_____ Rg1=_____ Ree1=_____

Rg1=_____

a

Part b, 7 points

DC bias



On the circuit diagram above, label the DC voltages at **ALL nodes** and the DC currents through **ALL resistors**

Part c, 6 points

Find the small signal parameters of Q1 and Q2.

Transistor Q1: gm=_____ Rce=_____ Rbe=_____

Transistor Q2: gm=_____ Rds=_____

Part d, 15 points.

Find the small signal voltage gain (Vd2/Vs2) of Q2 and Q2's small-signal input resistance.

Vd2/Vs2=_____

Rin,q2= _____

Part e, 15 points

Find the small signal voltage gain (Vc1/Vb1) of Q1 and the *** amplifier *** input resistance.

Vc1/Vb1= _____

Rin,amplifier =_____

a

Part f, 6 points

Find (Vout/Vin), (Vin/Vgen) and (Vout/Vgen)

(Vout/Vin) = _____

(Vin/Vgen) = _____

(Vout/Vgen) = _____

a

Part g, 14 points

Now you must find the maximum signal swings. Find the output voltage due to saturation and cutoff in Q2. ***Give the sign (+ or -) in your answers below.***

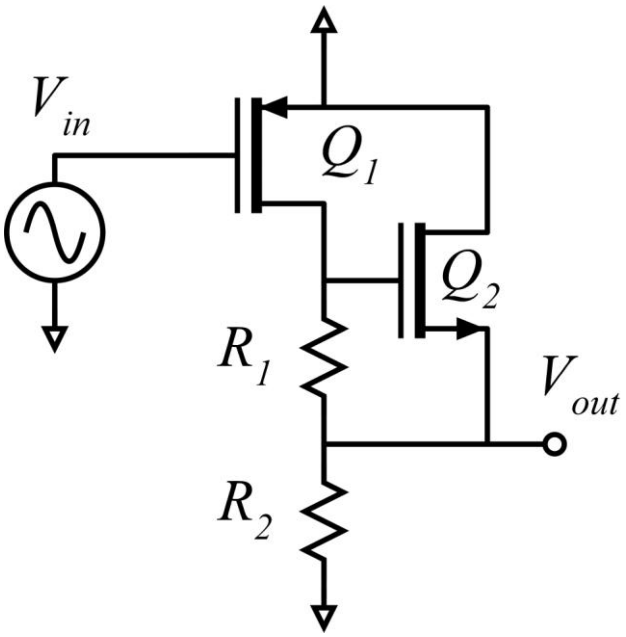
Cutoff of Q1; Maximum ΔVout resulting = _____

Saturation of Q1; Maximum ΔVout resulting = _____

Cutoff of Q2; Maximum ΔVout resulting = _____

Knee voltage of Q2; Maximum ΔVout resulting = _____

Problem 2, 30 points
nodal analysis



You will be working on the circuit to the left.

Ignore DC bias analysis. You don't need it.

Transistor 1 has transconductance gm1.
Transistor 2 has transconductance gm2.

The drain-source resistances Rds of both transistors are infinity (so you don't need to draw it!)

Part a, 12 points

Draw the small-signal equivalent circuit

Part b,13 points

Find, by nodal analysis, a small-signal expression for Vout/Vin.

Vout/Vin= _____

Part c, 5 points

gm1= 1 mS gm2= 10 mS , R1=1kOhm, R2=2kOhm
Give a numerical value for Vout/Vin.

Vout/Vin= _____