

ECE 137 A Mid-Term Exam

February 13, 2006

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 50 minutes.

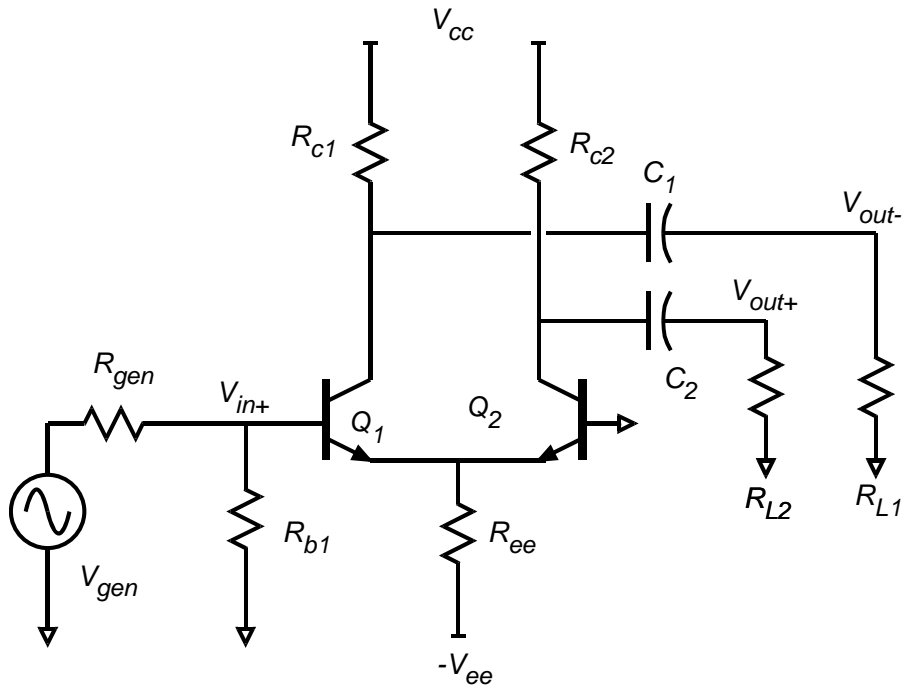
Use any and all reasonable approximations (5% accuracy is fine.), ***AFTER STATING and approximately Justifying them.***

Name: _____

Problem	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 and Q2: $\beta = 200$, $V_A = \text{infinity V}$

+V_{cc} = +5 volts.

-V_{ee} = -5 volts

R_{gen} = 500 Ohm

R_{L1} = R_{L2} = 2000 Ohm

R_{b1} = 1000 Ohm

R_{ee} = ???

R_{c1} = ???

R_{c2} = ???

C₁ and C₂ are very big and have negligible AC impedance.

Part a. 7 points

DC bias.

Q1 is to be biased with 3 mA emitter current.

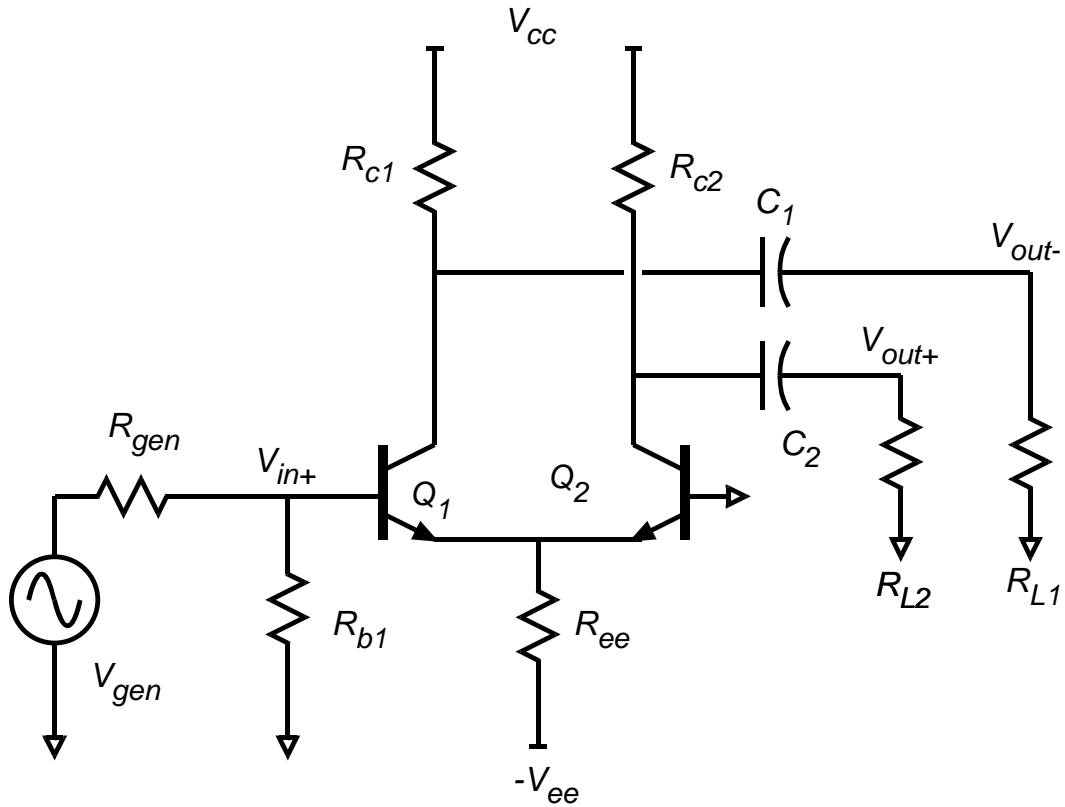
Q2 is to be biased with 3 mA emitter current.

The DC collector voltages of Q1 and Q2 are both +2.5 Volts.

Find: $R_{c1} =$ _____ $R_{c2} =$ _____ $R_{ee} =$ _____

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: $g_m =$ _____ $R_{ce} =$ _____ $R_{be} =$ _____

Transistor Q2: $g_m =$ _____ $R_{ce} =$ _____ $R_{be} =$ _____

Part d, 15 points.

Find the small signal voltage gain (V_{c2}/V_{e2}) of Q2 and Q2's small-signal input resistance.

$V_{c2}/V_{e2} =$ _____

$R_{in,q2} =$ _____

Part e, 15 points

Find the small signal voltage gain (V_{e1}/V_{b1}) of Q1 and the *** amplifier *** input resistance.

$V_{e1}/V_{b1} =$ _____

$R_{in, amplifier} =$ _____

Part f, 6 points

Find (V_{out}/V_{in}) , (V_{in}/V_{gen}) and (V_{out}/V_{gen})

$$(V_{out}/V_{in}) = \underline{\hspace{10cm}}$$

$$(V_{in}/V_{gen}) = \underline{\hspace{10cm}}$$

$$(V_{out}/V_{gen}) = \underline{\hspace{10cm}}$$

Part g, 14 points

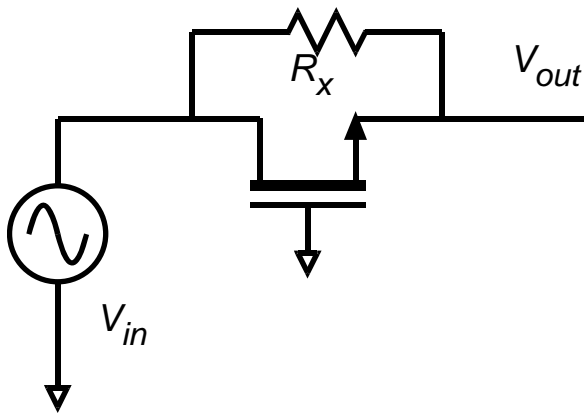
Now you must find the maximum signal swings. Find the output voltage due to saturation and cutoff in Q2. ***To save time, we are going to ignore the saturation and cutoff of Q1, even though it might be important. Give the sign (+ or -) in your answers below.***

Cutoff of Q2; Maximum ΔV_{out} resulting = _____

Saturation of Q2; Maximum ΔV_{out} 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.

The transistor has transconductance g_m . Its drain-source resistance R_{ds} is 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 V_{out}/V_{in} .

$V_{out}/V_{in} =$ _____

Part c, 5 points

$g_m = 10 \text{ mS}$ $R_x = 100 \text{ Ohms}$

Give a numerical value for V_{out}/V_{in} .

$V_{out}/V_{in} =$ _____