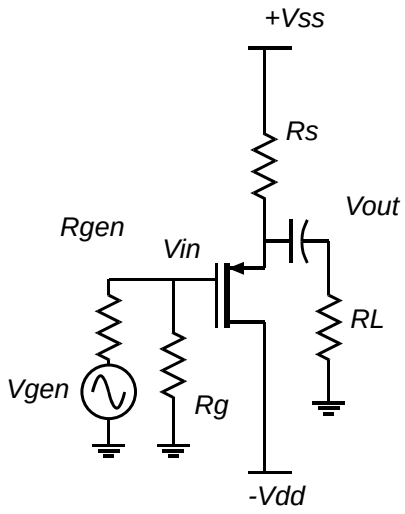
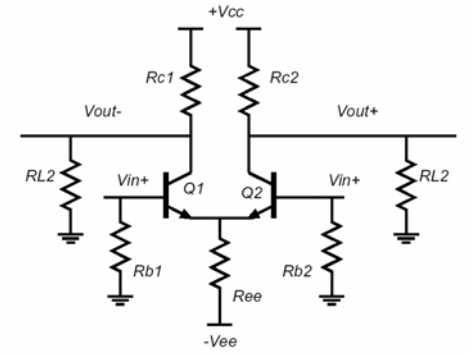
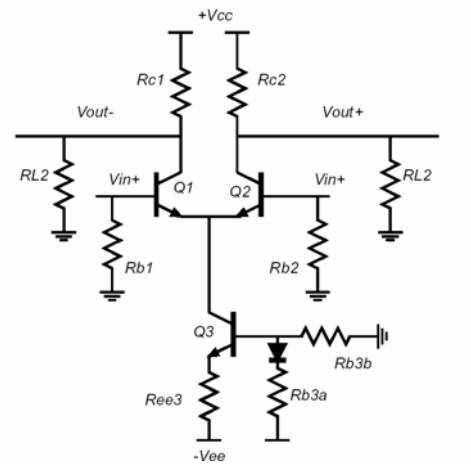
ECE137A Problem set #4







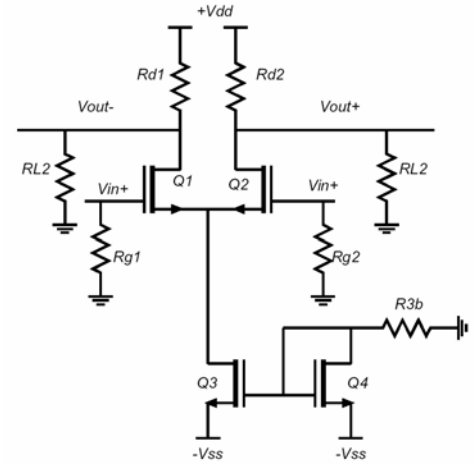
Problem 1 Common-drain stage. The PMOS FET has 1.2 nm oxide thickness, 250 nm gate length, and a -0.4 V threshold. Mobility is 200 cm^2/(V-s). 1/lambda is 15 V. Use a constant-mobility model.

Choose the gate width and Rs so that the transistor carries 5 mA and has 0.6 V on the source electrode. The load resistance is 1 kOhm, Rg is 1 MOhm, Rgen is 100 kOhm.

Find the bias conditions, the small-signal gains Vout/Vin, Vout/Vgen, and Vout/Vin, and find the input and output impedances.

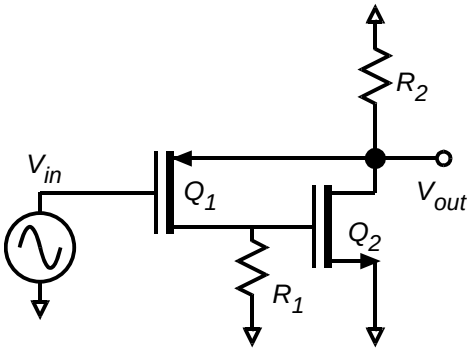
Problem 2 The circuit above uses 2n3904 bjts. -- use datasheet values for beta and Rce. For DC bias, Vin+ and Vin- are zero volts. Vcc= +5 V, Vee= -5V. The DC emitter currents are each 2 mA, and the DC collector voltages are 2.5 V. Rb1=Rb2=10 kOhm. RL1,2 are 10 kOhm. Find all resistor values. Find the bias conditions, the differential input impedance, the differential gain, and the common-mode rejection ratio.

Problem 3 The circuit now uses a constant current source to bias the differential amplifier. For Q1 and Q2, the DC emitter currents are each 1mA, while their DC collector voltages are 2.5 V. There is a 0.2 V IR drop across Ree3, while the DC current in Rb3a is 1/10th of the emitter current of Q3. Find all resistor values. Find the bias conditions, the differential and common-mode gains, and the common-mode rejection ratio. The diode has the same "on" voltage as the transistors.



Problem 4 The NMOS FET has 1.2 nm oxide thickness, 250 nm gate length, and a 0.4 V threshold. Mobility is 400 cm^2/(V-s). 1/lambda is 15 V. Use a constant-mobility model.

The supplies are + and - 1.5 Volts. Q3 and Q4 are to carry 1 mA drain current at Vgs=0.6 V. Q1 and Q2 are to operate at Vgs=0.6 V. The drain voltage is to be 1.0 Volts The load resistances are 5 kOhm. Find all resistor values. Find the bias conditions, FET widths, the differential and common-mode gains, and the common-mode rejection ratio.



Problem #5 . Nodal Analysis exercise. This is a "super-buffer". Ignore DC bias analysis. You don't need it. The two transistors have transconductance gm1 and gm2 respectively. Their drain-source resistances Rds1 and Rds2 are both infinity.
a) Compute Vout/Vin by nodal analysis.
b) find numerical values of Vout/Vin given gm1=10 mS, gm2=100 mS, R1=5kOhm, R2=500 Ohms.