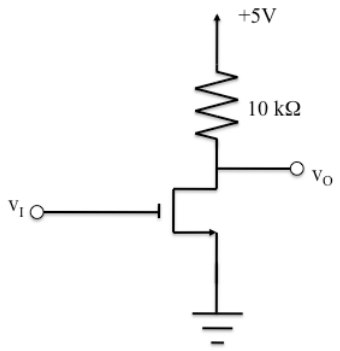
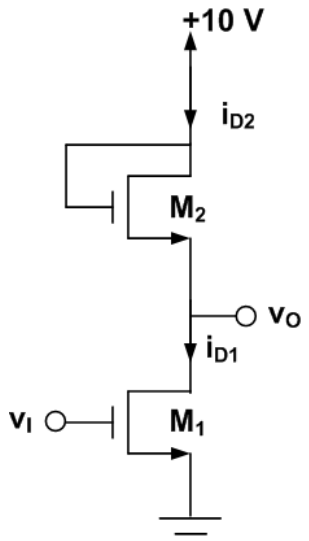
EE 315: Problem Set #8

1. Consider the following common source amplifier, where V_t= 1.5V, k'$_n$W/L = .2 mA/V^2.



a. Sketch the voltage transfer characteristic, clearly labeling the transition points, A, B and C.
b. The device is biased for a 0.15 mA drain current. Find the Q-point.
c. Find the voltage gain at this bias point.
d. Find the maximum amplitudes (i.e. no distortion/clipping) of the input and output signals assuming that the device remains in saturation.

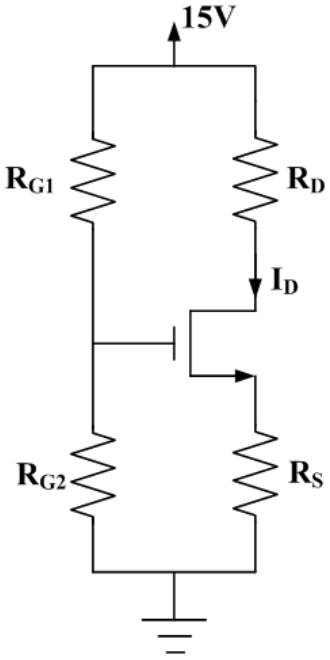
2. Consider the circuit below, which contains a common source amplifier in which the drain resistor is replaced with a load NMOS. The devices are characterized as



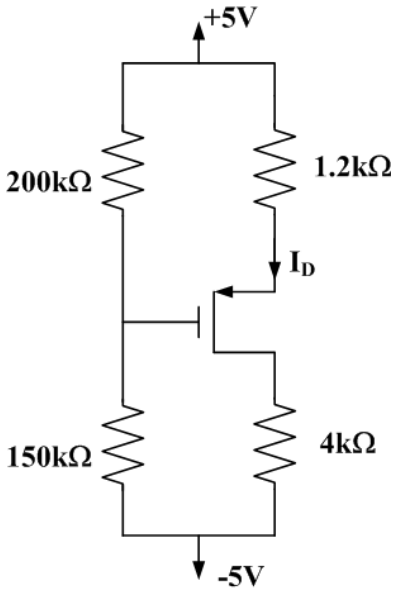
M1: V_{t1}= 1.0V, k'$_{n1}$W/L = 100 mA/V^2 and M2: V_{t2}= 1.0V, k'$_{n2}$W/L = 10 mA/V^2.

a. What are the modes of operation for the two devices for $V_{t1} \le v_I \le v_O + V_{t1}$.
b. Find the voltage gain, v_O/v_I.

3. Consider the circuit that needs DC biasing for a drain current of 2mA. The MOSFET parameters are V_t= 1.2 V, k'_n= 80 μA/V^2, W=240μm and L=6μm. The gate currents should be small, on the order of 1μA. The supply voltage should be dropped in thirds across the drain, the drain-source voltage, and the source. Find the resistor values.

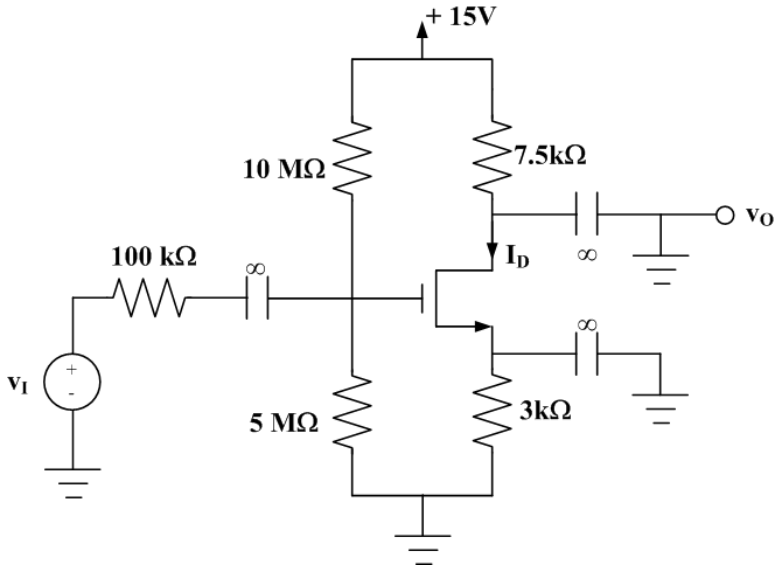


4. Consider the following circuit, where V_t=-1V and k'_pW/L=0.25mA/V^2. Find the gate-source voltage, the drain-source voltage and the drain current.



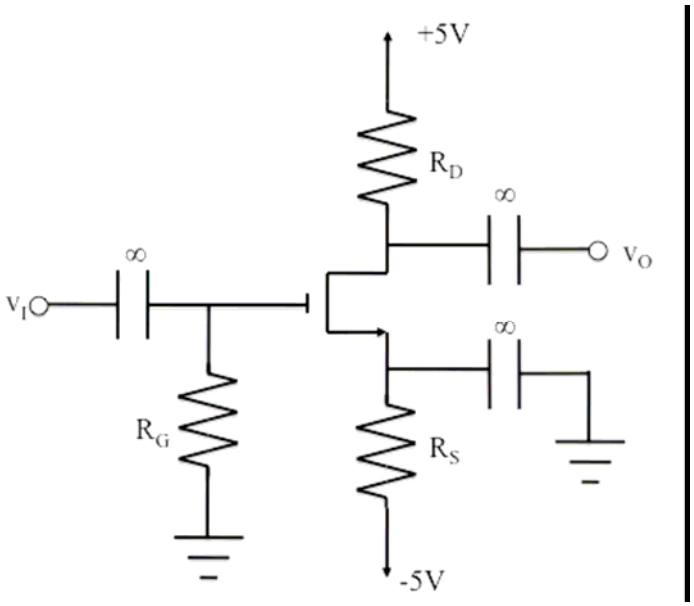
NOTE: For both problems, the capacitors behave like perfect open circuits at DC and perfect short circuits at the frequency of interest for small signal operation.

5. Consider the following common source amplifier where V_t= 1V, k'_nW/L = 2mA/V^2, and λ=0.01 V^{-1}.



   a. If the drain current is 1mA, find the dc voltages, V_{GS} and V_D.
   b. Find the values of g_m and r_o.
   c. Draw the small signal model and find the small signal gain, v_o/v_i and the input resistance, R_{in}.

6. Consider the following NMOS circuit where V_t= 1V, k'_nW/L = 0.8mA/V^2, and V_A=40V.



a. If the drain current is 0.1 mA, find the values of the resistors, R_G, R_D, and R_S, assuming that the input resistance at the gate is 10MΩ and that the maximum drain resistor is used such that an output swing of -1V to +1V is possible.
b. Find the input and output Q-point. Then find g_m and r_o for this Q-point.
c. A small signal source is connected to the input. The source has a voltageof v_i and a series resistance of 1MΩ. The output is terminated with a load resistor of 40kΩ. Find the voltage gain from the signal source to the load.