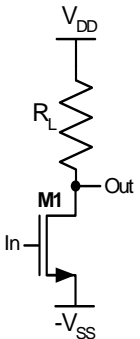
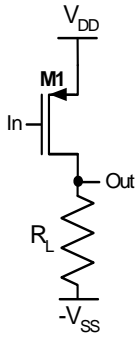


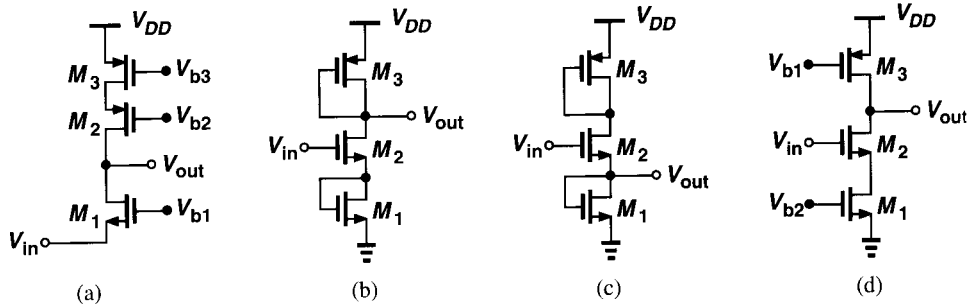
ECE 422/522
Homework #3 (Due Oct. 22)

Fall 2009

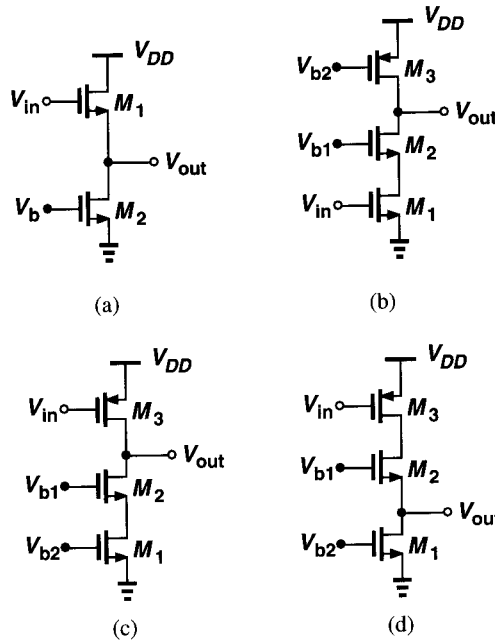
1. Complete the following table for the basic amplifier configurations. Assume the biasing is with a resistor of value R_L . Do not ignore the transistor r_0 . Clearly mark the input and output terminals.

| Amplifier Type | Transistor Type | | R_{in} | R_{out} | A_v |
|---------------------------------------|---|---|----------|-----------|-------|
| | NMOS | PMOS | | | |
| Common Source |  |  | | | |
| Common Gate | | | | | |
| Common Drain (Source Follower) | | | | | |

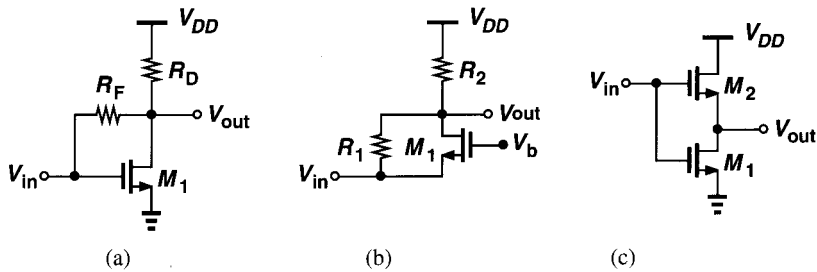
2. Assuming all MOSFETs are in saturation, write the expression for the small-signal voltage gain for each circuit shown below. Assume $\lambda \neq 0$, $\gamma = 0$.



3. Assuming all MOSFETs are in saturation, write the expression for the small-signal effective G_m for each circuit shown below. Assume $\lambda \neq 0$, $\gamma = 0$.



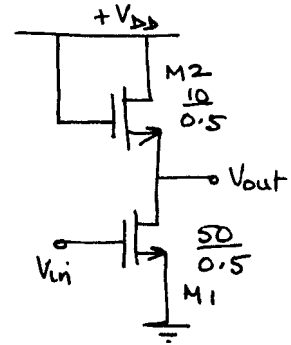
4. Assuming all MOSFETs are in saturation, write the expression for the small-signal effective G_m and R_o for each circuit shown below. Use these to determine the small-signal voltage gain. Assume $\lambda \neq 0$, $\gamma = 0$.



5. For the circuit shown assume $\lambda = 0$, $\gamma = 0$, $V_{DD} = 3V$. Use the following parameters: $V_{TO} = 0.7V$, $k' = 100 \mu A/V^2$

(a) At what input dc voltage is M1 at the edge of the triode/saturation regions. What is the small-signal voltage gain (v_{out}/v_{in}) under this condition?

(b) Verify your results with SPICE.

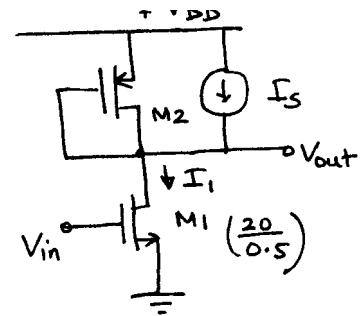


6. For the circuit shown $V_{DD} = 3V$, $I_1 = 1mA$, and $I_S = 0.75mA$. Assume $\lambda = 0$, $\gamma = 0$.

n-ch: $V_{TO} = 0.7V$, $k' = 100 \mu A/V^2$

p-ch: $V_{TO} = -0.9V$, $k' = 25 \mu A/V^2$

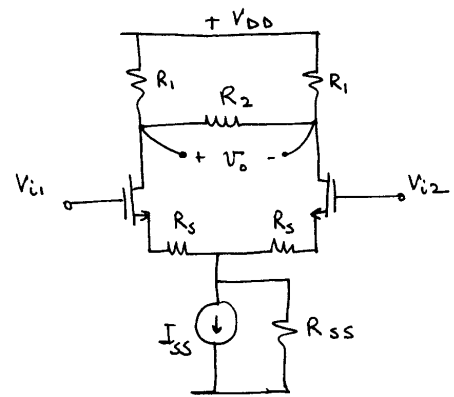
Calculate $(W/L)_2$ such that M1 is at the edge of the triode/saturation regions. What is the small-signal voltage gain (v_{out}/v_{in}) under this condition? Verify your result with SPICE.



7. a) Find the differential mode and common mode gains for the following circuit.

b) What is the CMRR for this circuit and what happens to the CMRR when R2 is removed the circuit.

c) Calculate A_{dm} & A_{cm} for $k' = 100 \mu A/V^2$, $V_{TO} = 0.7V$, $V_{DD} = 3V$, $V_{SS} = -3V$, $I_{SS} = 100 \mu A$, $W/L = 10 \mu m / 1 \mu m$, $R_1 = 1k\Omega$, $R_2 = 2k\Omega$, $R_S = 10\Omega$, $R_{SS} = 1M\Omega$. Verify your results with SPICE using the Level-1 model. Assume the dc bias input voltages are 0V.



8. Derive an expression for the differential low frequency small-signal voltage gain ($A_v = v_o/v_{id}$) for the amplifier as shown. Assume $g_{m1} = g_{m2} = g_{mx}$, $g_{m3} = g_{m4} = g_{my}$, $g_{m5} = g_{m6} = g_{mz}$ and $g_{m}r_o \gg 1$. Ignore the body effect.

