## Homework 7

ECE 5411 – CMOS Analog IC Design (Spring 2011)

Due on Wednesday, Mar 23, 2011.

**Note**: Use Cadence schematic capture, layout and Spectre simulation tools, available on the AMS servers for the homework problems.

Problems A: Do problems A21.14 and A21.16. Simulate only one of the problems.

**Problem B1:** Assuming all transistors are in saturation, find small-signal voltage gain for each of the circuits shown below. Use variables  $g_{m1}$ ,  $r_{o1}$ ,  $g_{m2}$ ,  $r_{o2}$ , etc.



**Problem B2:** Assuming all transistors are in saturation, find small-signal voltage gain for each of the circuits shown below. Use variables  $g_{m1}$ ,  $r_{o1}$ ,  $g_{m2}$ ,  $r_{o2}$ , etc.



**Problem B3:** The NMOS in the figure below has  $V_{THN} = 0.7V$ , and  $KP_n = 500\mu A/V^2$ . The drain current in the device is 1mA.



- a) Determine the small signal gain from  $v_s$  to  $v_{out}$ .
- b) Determine the W/L for the device and the DC operating points  $V_{GS}$  and  $V_{DS}$ .
- c) The lowest frequency in  $v_s$  is  $\omega_{in} = 100 \text{rad/s}$ . Determine the minimum values of  $C_1$ ,  $C_2$  and  $C_3$  required so that the frequencies associated with their charging/discharging is at least 10 times smaller than  $\omega_{in}$ .
- d) Determine the voltage swing limits at  $v_{out}$ . What is the amplitude of the largest sinusoidal input signal that can be applied before the output begins to clip?
- e) The supply voltage is changed to 5.5. Determine the small signal gain of the amplifier.