Homework Assignment No. 2

Due Friday, January 27, 2006 in class

Problem 1 - (10 points)

Problem 5.20 of Gray and Meyer. The SPICE parameters to use for this problem are:

.MODEL NPN NPN RB=200 BF=80 IS=1E-18 VAF=130
.MODEL PNP PNP RB=300 BF=20 IS=1E-18 VAF=50
.MODEL PMOS PMOS KP=26U LAMBDA=0.0125 VTO=-0.7 LD=0

Use the following table to summarize your answers for easier grading.
(a). Device Currents

	Hand Calculations	SPICE Simulations
I_{C1}		
I_{C2}		
I_{C3}		
I_{C5}		
I_{C6}		
I_{D1}		
I_{D2}		
I_{D3}		

(b). $V_{o(max)}$ = _____ $V_{o(mim)}$ = _____

P_{max} = _____

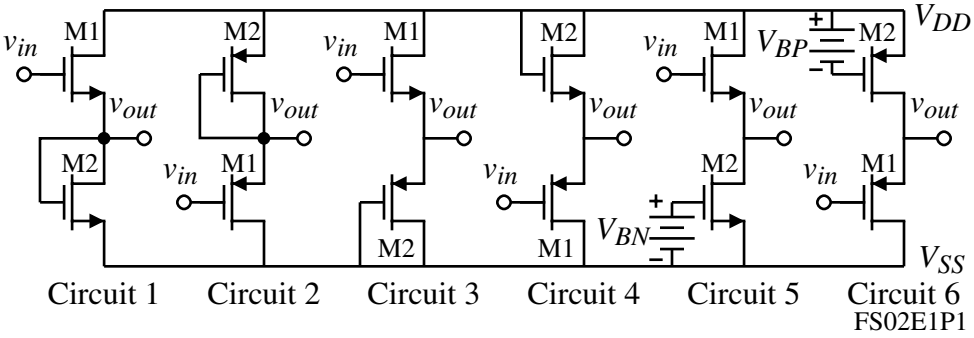
(c). SPICE Results

- A plot of the DC transfer characteristic and mark on your results where clipping begins to occur.
- Plots of i_{C1}, i_{C2}, and i_{D2} for v_o = 2V peak and v_o = 4V peak. Assume a signal frequency of 10 KHz. (Note: you will have to apply the appropriate dc bias and signal amplitude to achieve the desired output conditions.)
- Also use SPICE to compute the THD of the output voltage for both the 2V and 4 V conditions.

	Hand Calculations	SPICE Simulations
Clipping		
max		
min		
THD of v_o		
2V peak	NA	
4V peak	NA	

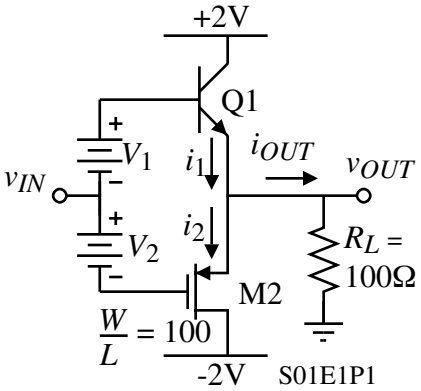
Problem 2 - (10 points)

Six versions of a source follower are shown below. Assume that $K'_N = 2K'_P$, $\lambda_P = \lambda_N$, all W/L ratios of all devices are equal, and that all bias currents in each device are equal. Neglect bulk effects in this problem and assume no external load resistor. Identify which circuit or circuits have the following characteristics: (a.) highest small-signal voltage gain, (b.) lowest small-signal voltage gain, (c.) the highest output resistance, (d.) the lowest output resistance, (e.) the highest v_{out}(max) and (f.) the lowest v_{out}(max).



Problem 3- (10 points)

A push-pull follower is shown which uses an NPN BJT and a p-channel MOSFET. In this problem, ignore the bulk effect, the channel length modulation, and the Early voltage. The parameters for the NPN BJT are $\beta_F = 100$, $I_s = 10$fA and $V_t = 25.9$mV. The model parameters for the PMOS are $K_P' = 50\mu A/V^2$ and $V_T = -0.7$V. (a.) Find the value of the dc batteries, V_1 and V_2, which will cause 120μA to flow in Q1 and M2 when the dc value of $v_{IN} = 0$VDC. (b.) Find the small-signal input resistance, output resistance and voltage gain when the dc value of $v_{IN} = 0$VDC.



Problem 4 - (10 points)

Derive an expression for the output resistance of the MOS Wilson current mirror shown in Figure 4.15 of GHLM. You must show your work to receive credit.