2022 Analog IC Design Homework 3 ***due date: 05/09/2022***

1. Use Composer and Hspice to simulate the differential pair as shown at Fig.1 with **Vdd=1.8V**. (30%)
   (a) Design a differential pair with gain $\mathbf{A_{DM} > 5}$ and $\mathbf{A_{CM} < 0.04}$ for both input common mode voltage = 0.6 and 1.8. (20%)
   (b) Simulate the frequency response of A_{DM} when input common mode voltage=1V, and base on the simulation parameter of .lis file to calculate dominant pole. (5%)
   (c) Simulate the frequency response of A_{CM} when input common mode voltage=1V, and identify what makes the A_{CM} deteriorate at the high frequency. (5%)

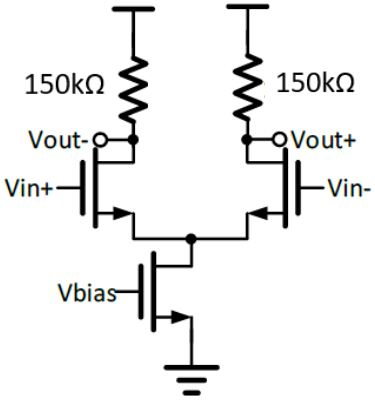

Fig. 1.

2. Design a **1:5** wide-swing cascade current source as shown in Fig. 2(a) with **Vdd=1.8V**. (40%)
   (a) With I_{ref} = 20uA (I_{out} = 100uA), design the W/L sizes of M_1~M_4, and the dc bias V_b to get R_{out} > 500kΩ when V_{out} = 250mV. (20%)
   (b) Use the circuit structure as shown in Fig. 2(b) as a reference to design a bias generation circuit of V_b with I_{in} = 20uA (I_{out} = 100uA). State the M_5's and M_6's (Fig. 2. (b)) design strategy and show in hand calculation. And express V_{in1}, V_{in2}, and V_{out} in terms of V_{ov} and V_{th}. (20%)

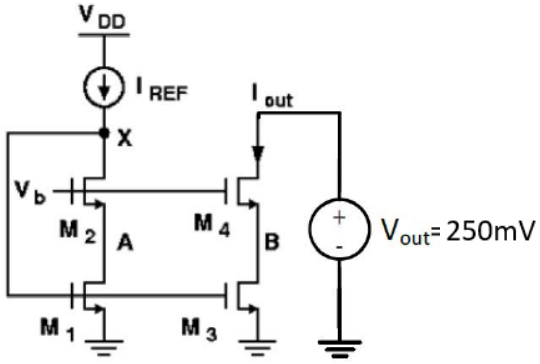

Fig. 2.(a)

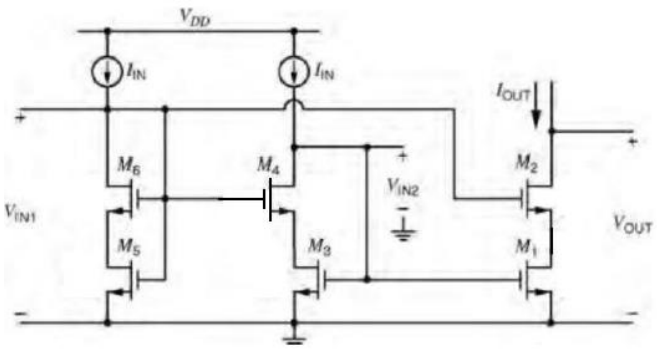

Fig. 2.(b)

3. Use Composer and Hspice to simulate the common source and source follower as shown in Fig. 3 with **Vdd=1.8V**. Every single one of MOS's cgtot, cstot, cdtot, and cbtot can't have more than 70fF under your design. (30%)

☆ ***Before you start to simulate the .ac noise***

1. Find the title "Flicker and Thermal noise Model Parameters" in "cic018.l".

2. Use the "replace all" to change value of the parameter into KF=1E-29.

3. Hint: use ".noise V(vout) vin 10000"

(a) Design a common source with gain A1>50 and plot the output noise's spectrum as shown in Fig.3. (a). Identify the corner frequency and pole of thermal noise. (6%)

(b) Design a source follower with gain A2>0.7 and plot the output noise's spectrum as shown in Fig. 3. (b). Identify the corner frequency and pole of thermal noise. (6%)

(c) Compare between (a) and (b). Which one has higher output flicker noise? Which one has higher thermal noise's pole? Why? (6%)

(d) Find the output thermal noise of CS and SF. Which one is bigger? Why? (6%)

(e) Find the input referred thermal noise of CS and SF. Which one is bigger? Why? (6%)

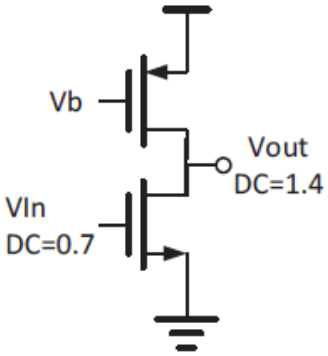

Fig.3 (a)

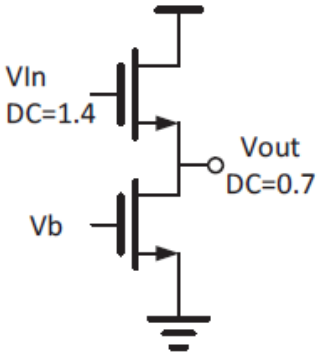

Fig.3 (b)

☆ ***The following should be included in your report (a) schematic (b) HSPICE netlist (c) waveform with cursor values (d) comments.***