EXAMINATION NO. 3

NAME_____SCORE_____/100

INSTRUCTIONS: This exam is closed book with one sheet of notes permitted. The exam consists of 3 questions for a total of 100 points. Please show your work leading to your answers so that maximum partial credit may be given where appropriate. Be sure to turn in your exam with the problems in numerical order, firmly attached together.

Problem 1 – Alan Hasting's Lecture (20 points)

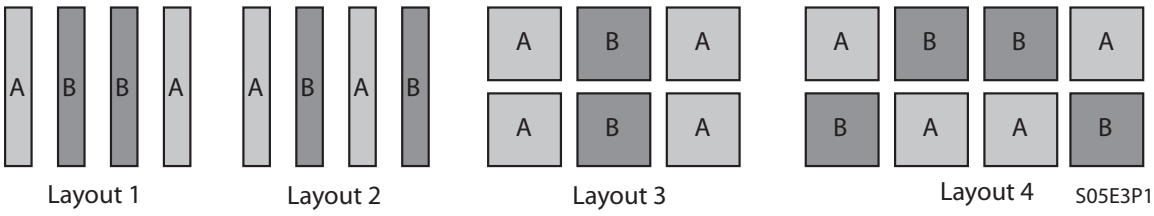
All questions are worth 4 points.

1.) What is the difference between random and systematic mismatches in IC layout?

2.) Give two ways in which random mismatches can be reduced.

3.) What is the difference in collector current between two identical BJTs whose base-emitter voltages are identical when there is 1°C difference in operating temperature at room temperature?

4.) Which of the following structures have common centroids?

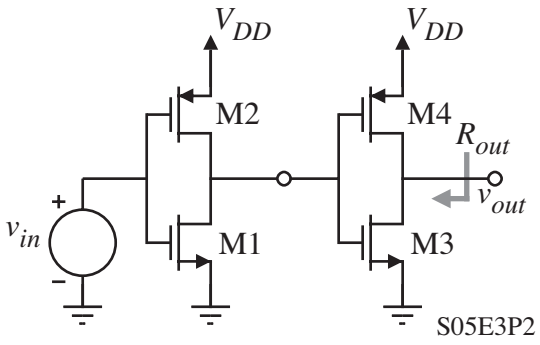


5.) Order the various rules for layout matching in order of importance. Place the number 1, 2, 3, or 4 beside the appropriate rule to indicate the importance (1 being the most important and 4 the least important).

Coincidence Symmetry Dispersion Compactness

Problem 2 – (40 points)

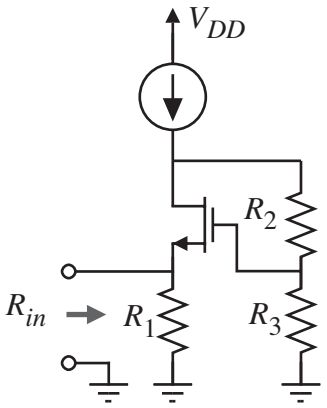
A simple amplifier consisting of two cascaded CMOS inverters is shown. By using one transistor (either NMOS or PMOS) and ideal current sources and batteries as necessary, show how you would reduce the output resistance to as small as possible. Estimate the output resistance of your circuit assuming that all transistors (those in the amplifier and the one you use) have the same value of g_m and r_{ds}. Further assume, that the CMOS inverters are operating in class AB.



Problem 3 - (40 points)

Use Blackman's formula to calculate the small-signal input resistance, R_{in}, of the circuit shown. Your answer should be in terms of the resistances R_1, R_2, R_3, g_m, and r_{ds}. Simplify your answer if $g_m r_{ds} >> 1$. Blackman's formula is,

$$R_{in} = R_{in}(g_m=0)\left[\frac{1 + RR(\text{port shorted})}{1 + RR(\text{port opened})}\right]$$



Extra Sheet