

**CMSC 613 Exam I**

Name:

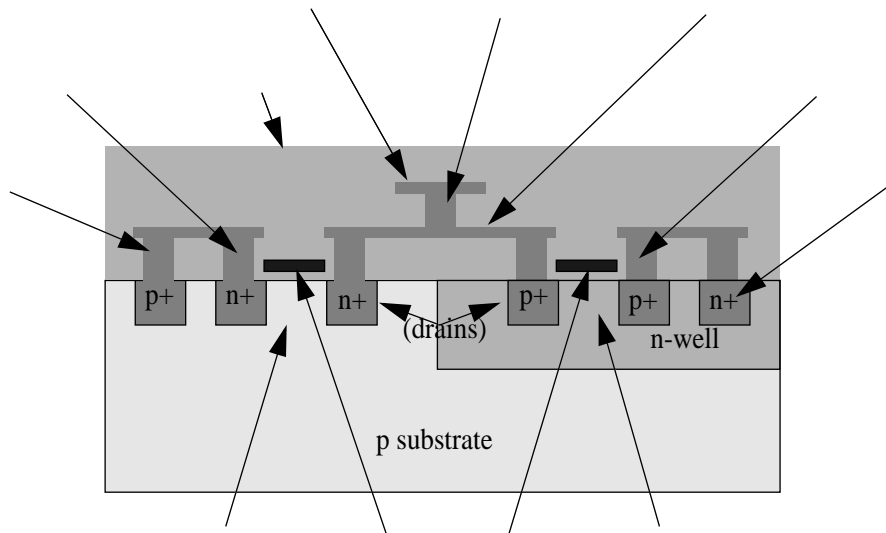
**This exam is 7 pages and has 4 questions.**

You must show all of your work -- partial credit may be given to partially correct answers, while answers with no justification may not receive full points. Use the back of the exam sheets if you need extra space.

1) a) (5pts) Briefly distinguish between abstraction and hierarchy in the context of the VLSI design process.

b) (6pts) Briefly explain why it is tractable (and popular) to automate the process of physical design using standard cell libraries, i.e., what characteristics of standard cells make it easier?

c) (6 pts) Identify the indicated components in the following cross-section.



d) (8pts) Briefly explain the difference between a latch and a flip-flop.

Give an example of a circuit architecture that (1) can make use of latches (2) requires the use of flip-flops.

Draw a transistor level diagram of a latch implemented using transmission gates.

2) a) (9pts) Reduce the following expression to the minimum CMOS representation. Assume only the **uncomplemented** inputs  $A, B, C, D$  and  $E$  are available. If choices exist, give the implementation that possesses the fewest number of inverted literals. Show your work:

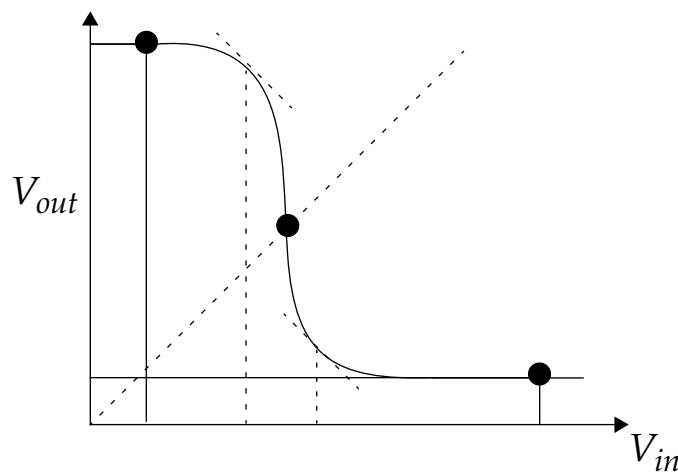
$$F = (\bar{A}B) + (C + D)\bar{E}$$

b) (8pts) Briefly describe the steps involved in performing photolithography.

c) (8pts) List two advantages and two disadvantages of SOI.

3) a) (8pts) Give three examples of noise sources (unwanted variations in voltage and current) in digital circuits.

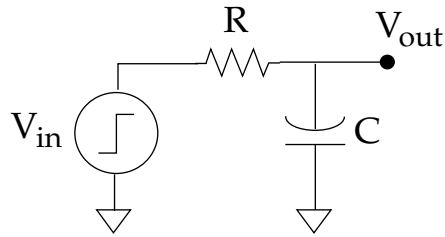
b) (9 pts) Label  $V_{OH}$ ,  $V_{OL}$ ,  $V_{IH}$  and  $V_{IL}$  in the following transfer curve:



c) (8pts) Define **directivity** as a quality metric for CMOS gates.

Identify the primary mechanism in the MOS transistor that reduces directivity.

4) a) (9pts) Give the expression for  $V_{out}(t)$  in the following first order RC model.



Derive from this expression a second expression giving the time it takes for the output voltage to reach 90% of its final output value in terms of tau.

b) (8pts) Give the expression for average power in terms of  $i_{supply}(t)$  for  $t = 0 \dots T$ .

Distinguish between static and dynamic power.

c) (8pts) Briefly describe a topic of your choice from the ITRS lecture slides. Do NOT write any more than 4 or 5 sentences.