exam2

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Part I

Instructions

Due Tuesday, December 2 by 11:00 a.m. to Prof. White or under his office door.

Neatly type out or write your answers on engineering paper. Clearly label the question you are answering. Show your relevant intermediate work and draw a box around your final answer. Use a single column of work (no prizes for fitting everything squeezed onto one page). Number your pages.

Use a cover sheet containing your name, section, and honor code.

You may not use:

- Wolfram Alpha
- any other web-based computer algebra system
- any online reference website such as Wikipedia

You may use:

- Jaeger textbook
- LTspice
- Matlab, Maple, Python, or other software package available on College of Engineering lab computers
- Any materials posted to either the course's Blackboard site or the auxilliary site http://whiteaudio.com/valpo/340

Part II

Problems

1 Problems from the Jaeger textbook

1.1 [15 pts.] 3.104. Also, part (f): Draw the waveform at the output node, include numbers for the various aspects of the waveform.

1.2 [10 pts.] 4.23

1.3 [10 pts.] 4.134 (a) and (c) only. Use the transistor parameters given at the beginning of the chapter problems.

1.4 [10 pts.] 6.31

1.5 [15 pts.] 7.6. part (a) only. Also find V_{IL} and V_{IH} for this inverter using the parameters given at the beginning of the chapter problems.

2 Short answer

2.1 [10 pts.] Draw the structure of an *n*-channel MOSFET. Include all terminals and indicate the *W* and *L* dimensions.

2.2 [10 pts.] Draw the structure of a *p*-channel MOSFET. Include all terminals and indicate the *W* and *L* dimensions.

2.3 [10 pts.] Describe how to fabricate both *n*- and *p*-type MOSFETs on the same silicon wafer. Assume the wafer is lightly doped *p*-type

2.4 [10 pts.] Silicon *pn* junction diodes are considered *minority carrier* devices, because it is the minority carrier concentrations on each side of the junction which determine the device current. Are MOSFETs also *majority carrier* devices? Explain why or why not.

3 Bonus questions

3.1 [+10 pts.] Jaeger problem 4.169

3.2 [+10 pts.] Ring oscillator

Download the "ring-osc.asc" LTspice schematic from the Exam 2 folder in the Content section of Blackboard.

Run the transient simulation and determine how the circuit works. Observe that there is no input signal source.

Describe how this circuit can be used to measure the average propagation delay $(t_p(avg) = \dfrac{t_{pHL} + t_{pLH}}{2})$ by only measuring the waveform's period (or frequency) at a single node. Provide an equation.