

OSU ECEN 4303 Digital Integrated Circuits, Fall 2023

HW 2: Introduction to Semiconductor Structures

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TAs: tbd

Assigned: Tuesday, 9/5, 2023

Due **Friday 9/15, 2023** (midnight)

Handin: <http://online.okstate.edu>

Please complete the following assigned problems from our textbook Y. Tsividis and C. McAndrew, Operation and Modeling of the MOS Transistor, 3rd Edition, Oxford University, 2011, ISBN-10: 0195170156, ISBN-13: 9780195170153. It is highly advisable that you start to use an engineering tool that allows you to plot and compute many of the items for these homework problems. MATLAB is highly recommended as a good tool of choice to learn many of the engineering concepts we will present in this course.

For problems listed here and future problems, you may be asked to plot certain items. I would use a program that decently plots items that include fully formatted axes, title as well as easily exports into a decent form (e.g., pdf). In my opinion, MATLAB has the best plotting capabilities, however, you are welcome to use any tool you feel comfortable with. I would strongly discourage you to use programs, like Excel, to plot results as they produce terrible output (again, in my opinion).

1. Problem 1.9 (for both one-sided (i.e., $N_D \gg N_A$) and two-sided np junctions) (Hint: start with a two-sided junction to make it easier for a one-sided junction).
2. Problem 1.10.
3. Consider a gate driving another gate. Both gates have the following characteristics: $V_{DD} = 5$ V, $V_{IL} = 1.35$ V, $V_{IH} = 3.15$ V, $V_{OL} = 0.33$ V and $V_{OH} = 3.84$ V. What are the low and high noise margins? Can the circuit tolerate 1.5 V of noise between the two? How about if I add some shielding to my circuit and drop the noise to 0.78 V of noise?
4. A minority gate produces a TRUE output if and only if fewer than half of its inputs are TRUE. Otherwise it produces a FALSE output. Sketch a transistor-level circuit for a three-input CMOS minority gate.

Note: Many of the problems in the text do not specify the value for the intrinsic concentration of silicon atoms. You should use the footnote at the bottom of page 4 in your textbook. Also, for all problems unless otherwise stated assume $T = 300$ K.