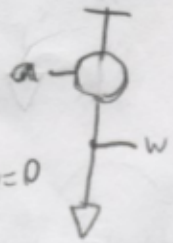
Switches, Transistors, and Logic Gates

CS 350: Computer Organization & Assembler Language Programming

Due Tue Nov 22

A. Why?

- Transistors (electronic switches) operate on binary data represented by voltages.
- Logic gates are the lowest level of hardware that deal with logical values.



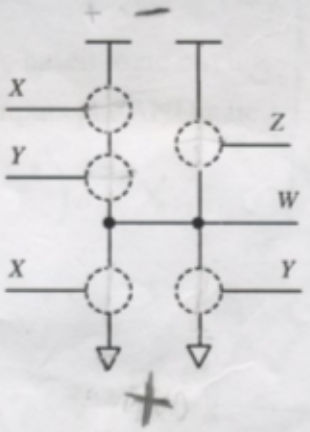
B. Outcomes

After this lab, you should be able to

- Be able to read and write simple voltage/current diagrams, transistor-level diagrams, and logic gates-level diagrams.
- Convert between truth tables, logical formulas, and loop-free logic circuits.

C. Problems [50 points total]

1. [16 pts] Study the voltage diagram shown here. Give a table that maps shows (for each configuration of inputs X, Y, and Z): Is power is connected to output W? Is W is connected to ground? What's the status of the circuit? ($W = 0$ or 1 or we have a short or open circuit?) See the table at the top of page 7 of Lecture 15 for an example.



2. [6 pts] Modify the voltage diagram for Problem 1 to get a proper CMOS circuit that calculates $W = \overline{X}\ \overline{Y} + \overline{Z}$. Don't modify the p-type transistors. Instead, add / remove / rewrite n-type transistors for X, Y, and Z as necessary.

3. [13 pts] Draw a transistor-level circuit for $Z = \overline{A}\,(\overline{B} + \overline{C})\,\overline{D}$. Be sure to (a) use p-type transistors to connect output Z to power iff $\overline{A}\,(\overline{B} + \overline{C})\,\overline{D}$ is true and (b) use n-type transistors to connect Z to ground iff $\overline{A}\,(\overline{B} + \overline{C})\,\overline{D}$ is false.

