CSCI 120 Introduction to Computation
Homework 3
Solution

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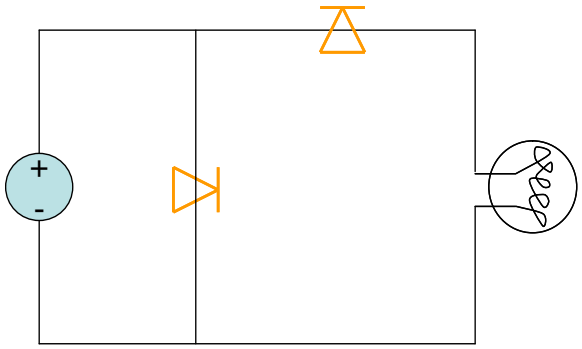
PART 1: Turn me on!
(a) Place the two diodes in such a way that the light bulb will be ON. Remember that electrons, like everything in nature, prefer to go through the easy path and, therefore, will avoid the light bulb, whenever possible.

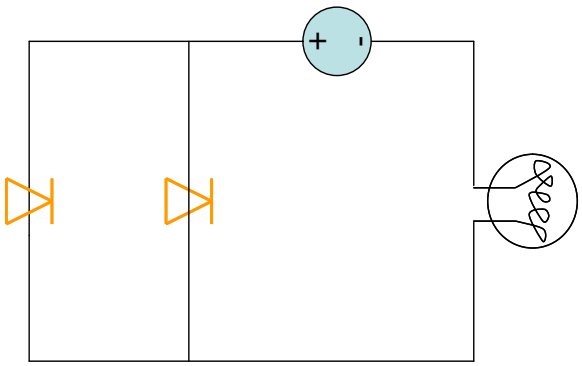


ANSWER: For the light bulb to be on:

- the horizontal line must be connected to allow current to flow from source to bulb
- the vertical line must be disconnected because otherwise it acts as a short circuit and prevents the current from flowing throught the bulb (electrons will like to avoid the bulb and go through the easy path)

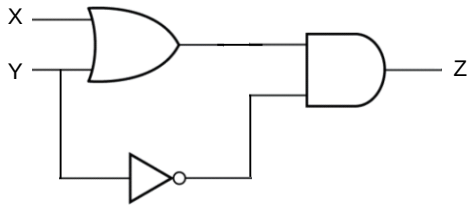
Therefore, based on the convention (high on tail low on head to conduct), the diode on the horizontal line must be turned clockwise, and the diode on the vertical line must be turned counterclockwise.

(b) Repeat (a) for the following diagram. There are many possible solutions in this case, because any closed path from the source to the lamp will work.



ANSWER: For the light bulb to be on, at least one of the horizontal lines must be connected. Therefore, based on the convention (high on tail low on head to conduct) at least one of the diodes must be turned clockwise.

PART 2: Playing with Boolean gates
(a) Fill up the truth table for the following logical circuit.

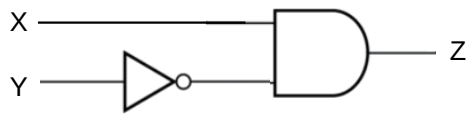


ANSWER:

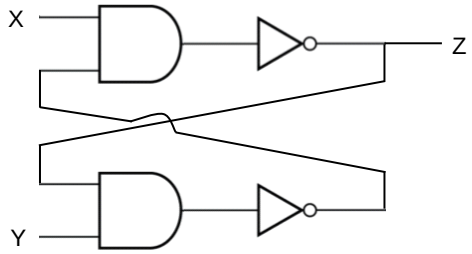
X	Y	Z
0	0	0
0	1	0
1	0	1
1	1	0

(b) Can you come up with a circuit with the same behavior but with less number of gates ?

ANSWER: Yes, the same behavior can be achieved using one AND gate and one NOT gate, as follows (construct a circuit from the thruth table using the 4 steps explained in class):



PART 3: Flip-flop
Consider the following circuit:



Assume that both of the inputs X and Y in the circuit above are 1.

(a) Describe what would happen if X were temporarily changed to 0.

ANSWER: If X is 0, then one of the inputs for the upper AND gate is 0. As a result, the output of the upper AND gate is 0. That is the input to the upper NOT gate; therefore, Z is 1. Changing X back to 1 will not change Z (trace the circuit to make sure). Z is stabilized at 1.

(b) Describe what would happen if Y were temporarily changed to 0.

ANSWER: If Y is 0, then one of the inputs for the lower AND gate is 0. As a result, the output of the lower AND gate is 0. That is the input to the lower NOT gate; therefore, the output of the lower NOT gate is 1. That is one of the inputs to the upper AND gate. Since X is 1, the upper AND gate outputs 1. That is the input to the upper NOT gate; therefore, Z is 0. Changing Y back to 1 will not change Z (trace the circuit to make sure). Z is stabilized at 0.

PART 4: Storage space
(a) Suppose a picture is represented on a computer screen by a rectangular array containing 1024 columns and 768 rows of pixels (tiny dots). If eight bits are required to encode the color and intensity of each pixel, what is the size of memory needed to hold the entire picture?

ANSWER: The number of pixels is 1024x768=786432. Each pixel requires 8 bit; therefore, each pixel requires 1 byte. The size of the memory must be 786432 bytes. This is 786432/1024=768 KB.

(b) Identify two advantages that main memory has over magnetic disk storage.

ANSWER: Main memory is almost 100 times faster because it has no mechanical movements. Main memory is Random Access but magnetic disk is sequential access (platters must rotate, arm must move).

(c) Identify two advantages that magnetic disk storage has over main memory.

ANSWER: Magnetic disk has usually more capacity. The cost of memory on magnetic disk is less per byte.

(d) Suppose that only 50 GB of your personal computer's 120 GB hard disk drive is empty. Would it be reasonable to use CDs to store all the material you have on the drive as a backup? What about DVDs?

ANSWER: We have 70 GB of data. The capacity of a single CD is approximately 700 MB. Therefore, to backup the data using CDs we need almost 100 CDs. However, a DVD can store up to few GBs and would be more appropriate for the task.

(e) What is the average access time for a hard drive disk spinning at 60 revolutions per second with a seek time of 10 milliseconds?

ANSWER: To access the data, the platters must rotate to the desired location, and the arm must move to place the read/write head above that location. The first part of the movement depends on the rotation delay. Since the hard disk makes 60 revolutions per second, one full rotation requires 1/60 sec = 0.01667 sec = 16.67 ms. On average, however, we expect to require half a rotation. Therefore, we need 8.34 ms. The second part of the movement depends on the seek time which is 10 ms. Therefore, the total time is 8.34+10=18.34 ms on average.

PART 5: Research
Do some online research to answer the following questions to the best you can:

(a) What technologies enable the optical matrial in DVD-RW and DVD+RW to be re-written? What is the difference between DVD-RW and DVD+RW?

ANSWER: See note 4.

(b) What is BluRay?

ANSWER: See http://www.blu-raydisc.com/