Homework 12 & Lab 12

## This is our last week of labs. The last day of class for this semester is May 1st. To ensure the TAs have enough time to grade all the homework and the lab reports, and to ensure you have time to study for our final exam, this week’s homework and lab is combined into one assignment. You will turn in the completed assignment by the end of this week (week of 4/27)’s lab section with your professor and your TA. This means that you should ask all the questions you have during our last Zoom session and make sure you finish everything before you click “leave meeting” on Zoom. Submit the completed work to the Blackboard – Homework 12.

1. *Switches*
2. As shown in our Lecture 12 video, the first question is to show how a NOT gate’s internal circuit works. I already walked you through the circuitry of a NOT gate when the input is 0 (low).
	1. Simulate the circuit I showed you in the lecture in Multisim and set the input to 1 (high). Show your simulation below and record the output voltage. Make sure you label all the components the same as I did. (10)
	2. Add voltage meters to the base of all 4 transistors. When the input is 1, which transistors are on and which transistors are off? Draw the current flowing paths starting from VCC to possible grounds or outputs. You can take a screenshot and use any note-taking or graphic editing tools to draw. (10)
	3. Review how the input is 0, the output is 1 (~3.3V), and now you see how the input is 1, the output is 0 (~0V). This is exactly how a NOT gate supposed to behave. Use your own words to describe how its internal circuit works. Break down your explanation into three stages: Input stage, Control stage and Totem-pole output stage. (10)
3. A NAND gate works very similarly as a NOT gate. A NOT gate has one input and one output. A NAND gate has at least two inputs. The NAND truth table is as following:

|  |  |  |
| --- | --- | --- |
| INPUT A | INPUT B | OUTPUT $X=\overbar{AB}$ |
| 1 | 1 | **0** |
| 1 | 0 | **1** |
| 0 | 1 | **1** |
| 0 | 0 | **1** |

The Boolean equation for the NAND gate is written $X=\overbar{AB}$. The inversion bar is drawn over A and B, meaning that the output of the NAND is the complement of A and B – **NOT (A and B).** NAND’s output is always HIGH unless both inputs are HIGH.

Build a NAND gate by modifying the NOT circuit your built: Add another input NPN transistor labeled as $Q\_{1-2}$. Use another SPST switch to mimic the high-low input. Do add a second diode to protect the input transistor from negative voltages that might inadvertently be placed at the input. Show your simulations below. Take 4 screenshots that represent the 4 possible logic states of the truth table above. Show the voltage meters values for all four. (20 points, 5 points per one)

1. *Number systems*

Show your work. 1 point per one, 18 points in total.

1. Convert the following binary numbers to decimal.
	* 0110
	* 0011 0111
	* 1010 0111
2. Convert the following decimal numbers to 8-bit binary.
	* 186
	* 214
	* 27
3. Convert the following binary numbers to octal.
	* 11101
	* 1011100
	* 1101101
4. Convert the following binary numbers to hexadecimal.
	* 0111 0100
	* 1100 0110
	* 1011 1001
5. Convert the following decimal numbers to hexadecimal.
	* 127
	* 252
	* 29
6. Covert the following BCD numbers to decimal.
	* 1001 1000
	* 0111 0100
	* 1000 0001
7. *Python*
8. Install Python 3.8.2 to your computer.
9. Install pip 20.0.2.
10. Install these useful Python libraries: numpy, matplotlib, scipy, pandas and statsmodels.
11. Write a program with Python to show how virus infection grows exponentially and how *#StayHome* can help. You certainly have studied my example but don’t copy and paste. Turn my video off and try to write the program on your own. You can make up your own parameters and plot style & legends.
* Show your code. (6)
* Show your plot. (6)