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Digital Lab 1 Worksheet

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Course/Section CE-1205-002

Please complete the following steps to complete the first digital lab:

1. Using a type A to micro B USB cable, connect the breadboard to the USB port of the computer.

2. Using a multi-meter, measure the difference between the red and black wires on the board and record below. It should be around 5V, but it will not be exactly.

The voltage was 4.097 V

This is the voltage that is provided your flash drives and phone chargers when you plug them into the computer.

3. Take the blue LED and a 220 ohm resistor (red-red-brown) in series as shown in the circuit above and connect them across the red and blue distribution strip at a point by the USB connector so it is out of the way for the next steps. It should glow brightly.

4. Locate a 74HC08 chip and plug it into the breadboard. You may need to turn the chip on it's side and gently straighten out the pins if they are two wide to plug into the breadboard. The plugs should straggle the gap between rows of 5 on the breadboard.

5. Using a red and a black jumper wire, connect pins 14 and 7 of the chip to the 5V and 0V (red and blue) distribution strips so that AND gates are powered. Red is used to 5V and black is used for 0V.

6. Connect the center connection of two slide switches to the A and B inputs of the AND gate (use any of the 4 AND gates in the chip). Now, connect two pairs of red LEDs and resistors in series and connect to the center connection of the two switches. You should be slide the switch from left to right and see the LED turn on and off for the corresponding switch. You are now sending '1'/true and '0'/false signals to the two inputs of an AND gate.

7. Measure the voltage of the two slide switches which provide the AND gate inputs and record below the voltages and LED status below:

Switch A	Voltage at A input of gate	Red LED on?
'0' (connected to the black wire)	0.00	No
'1' (connected to the red wire)	5.079 ~ 4.89	Yes

Switch B	Voltage at B input of gate	Red LED on?
'0' (connected to the black wire)	0.00	No
'1' (connected to the red wire)	5.066 ~ 4.8	Yes

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8. Connect the output of the AND gate to an orange LED and resistor in series. Now, slide the two switches to all four combinations and record the observations below.

Switch A	Switch B	Voltage at Y output	Orange LED on?	
0	0	0.00	No	0 false
0	1	0.02	No	0 false
1	0	0.04	No	0 false
1	1	4.67	Yes	1 True

An LED on indicates the output of the gate is true/'1'. Verify that this matches the table shown in the introduction. The orange LED shows the evaluation of A && B.

9. Find space on the breadboard for a 74HC32 (OR gate). Connect it to power as in step 5. Connect the A and B inputs of the AND gate to the A and B inputs of the OR gate.

10. Connect the output of the OR gate to an yellow LED and resistor in series. Now, slide the two switches to all four combinations and record the observations below.

Switch A	Switch B	Voltage at Y output	Yellow LED on?
0	0	0.00	No
0	1	3.52	yes
1	0	3.47	yes
1	1	4.46≈5.15V	yes

0 False
1 True
1 True
1 True

An LED on indicates the output of the gate is true/'1'. Verify that this matches the table shown in the introduction. The yellow LED shows the evaluation of A || B.

11. Find space on the breadboard for a 74HC04 (NOT gate). Connect it to power as in step 5. Connect the A inputs of the NOT gate to output of the OR gate.

12. Connect the output of the NOT gate to a green LED and resistor in series. Now, slide the two switches to all four combinations and record the observations below.

Switch A	Switch B	Voltage at Y output	Green LED on?
0	0	4.54	yes
0	1	1.27	No
1	0	2.34	No
1	1	0.02≈0.0	No

An LED on indicates the output of the gate is true/'1'. Verify that the output is the yellow and green are the inverted versions of each other. The green LED shows the evaluation of !(A || B).

13. Write a short C program, compiled with GCC, on the RPi 3b/3b+ that:

a. Accepts two integers (A and B) from the user.

b. Displays the value of A && B, A || B, and !(A || B) on the screen.

c. Verify that these outputs match the values in steps 8, 10, and 12.

14. Lab checkout steps:

a. Show your working circuit and program to the grader.

b. Create a file, **lastname_netid_lab2.zip** (where lastname is your lastname and net ID is in the form abc1234), that includes the following files:

- A JPEG image of your working circuit

- The source code your your program

- The output of your program

- This completed lab worksheet with all data completed

c. Upload the zip file to Canvas.

d. After your have your picture and send the zip file, dismantle your circuit and return everything to the box on the shelf. Do not remove the USB adapter, slides switches, or the pre-loaded red and black wires.

Thank you for attending the lab. We hope some of this material was new and interesting to you.

In the next lab, we will explore clock-driven digital circuits and understand how clock speed affects how fast operations occur in the computer. We will also explore how conditional expressions like A < B, A == B, and A > B work in hardware.

Drs. Losh and Eary