Lab 02 – Assignment and Upload Sheet

Place your answers to the Lab 02 Questions here, then upload this document to Blackboard in either PDF or Word format as your response to the Lab 02 Assignment. Download your work to check that your upload was successful.

## Fill in your answers here for In-Lab work [15 points]:

Question 1. [5 POINTS] Record here the resistance values that you measured for your pushbutton switch along with the switch condition (Open or Closed) for each resistance value.

**.1 closed**

**.1 open**

Question 2. [5 points for part c computation] After you have a working XNOR circuit, use a lab multimeter to make the following voltage measurements on that circuit.

1. Measure and record the voltage between the +5 volts red power bus of your breadboard and the blue ground bus (0 volts) on your breadboard. Two easy places to make the electrical connection between these buses and the two probes will be tie points I1 (against the bit of bare metal showing of the 10 ohm resistor lead) and the nearby black wire’s little bit of expose metal at the end of the blue bus). **5.08 V**
2. Measure the voltage between one of the voltage divider outputs and ground (it does not matter which one output, A’ or B’, that you choose) when (1) the pushbutton switch of that divider is not pushed and (2) when it is pushed. Record the two voltages and whether the switch is being pushed on nor for each. **5.07 V open 0 Closed**
3. [5 POINTS for this part] Using the voltage divider equation, the resistance data that you measured for Question 1, and the voltage that you measured for Question 2a, compute the expected two voltage divider circuit output voltages. Record here the two computed voltages and the difference between each computed voltage and its corresponding measured output voltage. **5.08 \* .1/.1 = 5.08 Ideal**

**5.07 Actual = Difference of .01**

**0 \* .1/.1 = 0 which is the same as actual**

Question 3. [5 POINTS] Measure the voltage between the output of NAND1 (replaced by a NOR gate, as discussed in the Instructions) and ground when the switch button for input B is not being pressed and record this datum. Then press the switch button and record the voltage.

**5.15 V**

20 POINTS: Before you leave lab, show your TA your working XNOR circuit.

15 POINTS: Before you leave lab, with your TA, discuss the data you gathered with the multimeter and answer questions about your circuit.

**Take-Home Lab Assignment [50 points]**

**Due at the start of your lab session next week. This file, with your answers, must be uploaded to Blackboard before your lab session starts and you must bring a completed circuit to demonstrate.**

Build a combinatorial digital logic circuit using components in your lab kit to implement the following Boolean function.

* The circuit should take in three one-bit inputs called A, B, and C, in the form of three voltage divider circuits built from a 10,000 ohm resistor and a push button switch. These three inputs should be built as active-high, that is, pushing a switch button should create a high voltage to send to the combinatorial logic portion of the circuit. NOTE: Keep in mind that the inputs you built in lab were active low (1 when not pressed/ 0 when pressed).
* The combinatorial circuit to be built treats the input bits A, B, and C as representing an unsigned decimal integer from zero (inputs ABC = 000) to seven (inputs ABC = 111). When the number of letters in the name of the decimal number is even, e.g., ABC represent an element of {zero, four, five}, then the circuit output is to be a logic 1 represented by a high voltage. When the number of letters is odd, e.g., {one, two, three, six, seven}, the circuit output should be a logic 0 and a low voltage.
* The combinatorial logic circuit must be built using only two-input NAND gates.
* The circuit should light an LED when the logic function value is 1 and the LED should be unlit when the logic function value is 0.

Fill in your answers below and upload to Blackboard [30 points]. Demonstration and Q&A in lab next week [20 points].

1. [10 points] Write out the truth table for the logic function to be implemented by the circuit.

|  |  |  |  |
| --- | --- | --- | --- |
| A | B | C | Out |
| 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 |
| 1 | 0 | 0 | 1 |
| 1 | 0 | 1 | 1 |
| 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 0 |

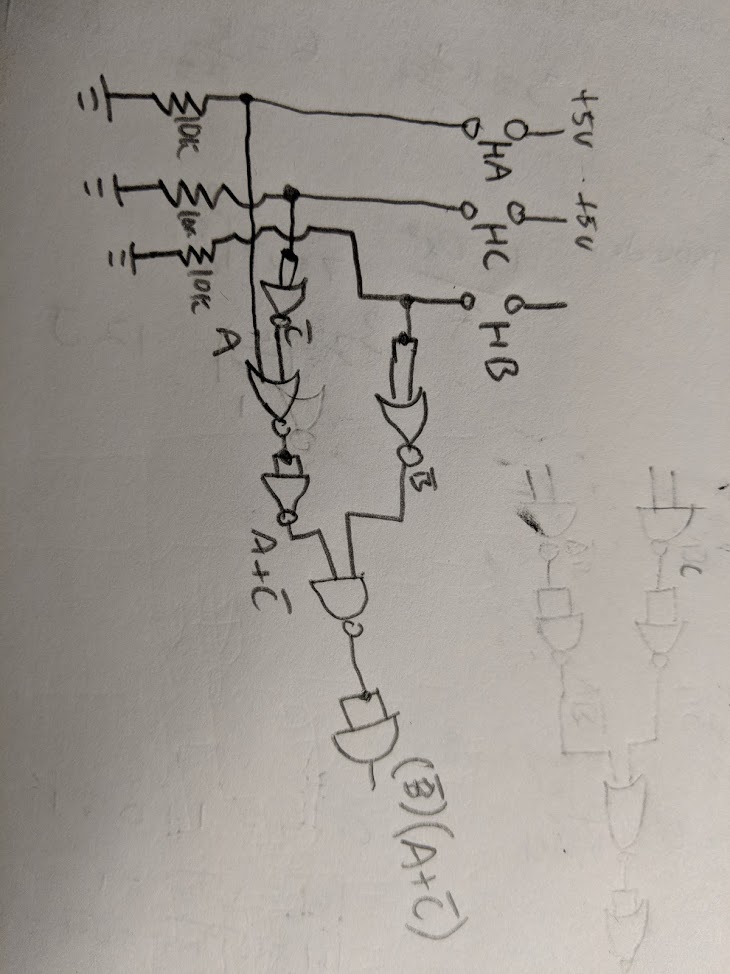
1. [10 points] Use a Karnaugh Map to create a Sum of Products (SOP) Boolean expression for the logic circuit in terms of two-input AND and two-input OR operations. Then use DeMorgan’s Law to convert your SOP expression into an expression using only 2-input NAND gates. Write both expressions here.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| A\BC | 00 | 01 | 11 | 10 |
| 0 | 1 | 0 | 0 | 0 |
| 1 | 1 | 1 | 0 | 0 |

SOP = A’B’C’ + AB’C’ + AB’C = B’C’ + AB’

POS = (A’+ B’+ C) (A’+B+C) (A’+B+C’) (A+B+C) (A+B+C’)

= (B) (A’+C)

1. [10 points] Draw the circuit schematic for the NAND implementation and be sure to include the input voltage dividers and the output LED. Your diagram will have much in common with the diagram for the circuit that you build during lab.  
   
2. [20 points] **I**mplement your designed circuit on your breadboard and bring it to lab next week. There, you will demonstrate to your TA the correct functioning of the circuit as defined by the truth table [10 points]. Be prepared to answer questions about your design and the circuit operation [10 points].

**You will not get to work on this take-home assignment during next week’s lab; lab take-home work will be checked at the beginning of lab.**