ECE 270 Lab Verification / Evaluation Form

Experiment 3

Evaluation:

IMPORTANT! You must complete this experiment during your scheduled lab period. All work for this experiment must be demonstrated to and verified by your lab instructor *before the end* of your scheduled lab period.

STEP	DESCRIPTION	MAX	SCORE
Pre-Lab 1	Function Representation	3	
Pre-Lab 2	Schematic	5	
1	Circuit Construction and Verification	6	
2	Propagation Delay Measurements	3	
3	Floating Input Investigation	3	
4	Thought Questions	5	
	TOTAL	25	

Signature of Evaluator: ____

Academic Honesty Statement:

IMPORTANT! Please carefully read and sign the Academic Honesty Statement, below. *You will not receive credit for this lab experiment unless this statement is signed in the presence of your lab instructor.*

"In signing this statement, I hereby certify that the work on this experiment is my own and that I have not copied the work of any other student (past or present) while completing this experiment. I understand that if I fail to honor this agreement, I will receive a score of ZERO for this experiment and be subject to possible disciplinary action."

Last Name (Printed): ______________________ **Lab Div:** _____ **Date:** ____________

E-mail: __ __ __ __ __ __ __ __ @purdue.edu **Signature:** ______________________

Implementation of Dual and Complement Functions

Instructional Objectives:

- To learn how to implement simple logic functions using discrete 74HC-series components
- To review the difference between the *dual* of a function and the *complement* of a function
- To review how to measure logic signal propagation delays using the digital oscilloscope

Pre-lab Preparation:

- Read this document in its entirety
- Complete the **Pre-lab Steps**

Lecture/Demonstration:

Your lab instructor will give a brief presentation that includes the following:

- A review of dual and complement functions, illustrated using a complete example similar to the one that will be completed for lab
- A demonstration of the completed experiment

Experiment Description:

Using only a 74HC00 (quad 2-input NAND, designated “U1”), a 74HC10 (triple 3-input NAND, designated “U2”), and a 74HC04 (hex INVERTER, designated “U3”), realize the following three functions (*simultaneously*):

(1) $F(X,Y,Z) = X \bullet (Y' + Z) + X' \bullet Y$

(2) $F'(X,Y,Z)$ *the COMPLEMENT of function F, above*

(3) $F^D(X,Y,Z)$ *the DUAL of function F, above*

Use mini DIP-switches for inputs and RED (resistor) LEDs for outputs.

Pre-lab Step (1): Function Representation

Fill out the truth table, below, for the three functions you are to implement in this lab experiment. Show how you derived the truth table for each function. Have a written copy of your derivatory work available for your lab instructor to check.

X Y Z	F(X,Y,Z)	F′(X,Y,Z)	F^D(X,Y,Z)
0 0 0			
0 0 1			
0 1 0			
0 1 1			
1 0 0			
1 0 1			
1 1 0			
1 1 1			

Pre-lab Step (2): Schematic
Draw a complete schematic for your circuit using OrCAD Capture. Be sure to label all inputs and outputs, and include the DIP switches, pull-up SIP resistor, and LEDs. Print a copy of your schematic and have it available for your lab instructor to check. **Note: *Hand-written schematics will not be accepted.***

Step (1): Circuit Construction and Verification
After constructing your circuit, fill out the truth table, below, to verify its operation (i.e., provide your circuit with each possible input combination and note the three function outputs). After completing the truth table below, compare it to the truth table you completed for **Pre-lab** (1). If there are discrepancies, you will need to "debug" your circuit/design! Have your lab instructor verify the functionality of your circuit.

X Y Z	F(X,Y,Z)	F′(X,Y,Z)	F^D(X,Y,Z)
0 0 0			
0 0 1			
0 1 0			
0 1 1			
1 0 0			
1 0 1			
1 1 0			
1 1 1			

Step (2): Propagation Delay Measurements
For each of the three functions, measure the rise and fall propagation delay (i.e., t_{PLH} and t_{PHL}). This can be done by connecting the oscillator module and frequency divider circuit (constructed for Experiment 2) to one of the function inputs while supplying a *fixed* combination (using DIP switches) to the other two inputs. NOTE: Choose a combination that will cause the function output to change state in response to the periodic input change provided by the 10 MHz frequency divider output – note that a different combination *may* be needed for each function.

Delay	F(X,Y,Z)	F′(X,Y,Z)	F^D(X,Y,Z)
t_{PLH}			
t_{PHL}			

Step (3): Floating Input Investigation
Disconnect the function input connected to the oscillator output (used in Step (2), above) and allow the disconnected function input to "float" (i.e., do not reconnect it to the DIP switch). Also, disconnect the power supply from the oscillator module. Observe what happens as you touch and then release the end of the wire. Record your observations in the space below.

Step (4): Thought Questions
Place your answers to the following "thought questions" in the space provided below:

(a) Which function was the "fastest"? Does this agree with your intuition based on how you realized that function?

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(b) Which function was the "slowest"? Does this agree with your intuition based on how you realized that function?

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(c) Compare the propagation delay values you measured for your circuit in Step (2) with those your lab partner measured for his/her circuit. What was the maximum difference observed between measurements of the same parameter? What do you think caused your measurements to differ?

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(d) Compare your observations for Step (3) with those of other students. Did your circuit behave the same when the "floating" wire was touched/released? Did your circuit take a longer/shorter time to change its output relative to your partner's when the wire was touched/released? If there were differences between how the circuits responded, what do you think caused them?

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(e) Based on your analysis and observations, is F a *self dual* function? Why or why not?

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