LATHROP ENGINEERING

Name:

UNIT 4: DISPLAYS

Digital Electronics Unit Due Date: **November 8, 2019**

Welcome to the fourth unit of *Digital Electronics*! We've covered a lot of topics in the circuit design process these last few months. We started with basic circuit theory, built AOI circuits in Multisim and by breadboarding, and learned how to simplify logic expressions and circuits using NAND and NOR gates. Now, our job turns to learning new tools for developing efficient circuits. In the end, the expectation is that you learn the following elements of digital logic:

- How circuits can display numbers and letters using seven segment displays
- How multiplexers combine multiple signals into just one signal
- How demultiplexers break up single signals into multiple signals
- How XOR and XNOR gates work and when they are useful
- How to do simple math in binary including adding, subtracting, and representing negatives

As we move through this unit, you are responsible for making adequate progress through the assignments, and for being done by the Unit Due Date (**November 8, 2019**). You are also responsible for completing each part before moving on to the next. Our unit is broken up into three main parts:

Part 1: **7-Segment Displays** *(40 pts) Approx. 2 days*		
The beginning of our unit introduces the Seven Segment Display. This digital electronics tool takes multiple inputs to turn on/off led segments shaped like a number. These displays are used in many applications like digital clocks, and here we'll get to learn how the signals are created.		Notes on 7-Segment Displays
		7-Segment Displays Assignment
		Multisim Circuits
		Check-off from Mr. Benshoof

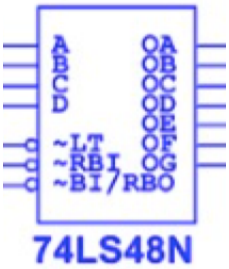
Part 2: **MUX/DEMUX** *(40 pts) Approx. 3 days*		
Our next part introduces multiplexers (MUX) and demultiplexers (DEMUX) as tools for working with multiple signals. You'll look at how seven segment displays can be used to show letters, and then create circuits that use demultiplexers to show specific words. The use of MUX and DEMUX will continue as we create various counters in the next part.		Notes on MUX/DEMUX
		MUX/DEMUX Assignment
		Multisim & Breadboard Circuits
		Check-off from Mr. Benshoof

Part 3: **Binary Math** *(50 pts) Approx. 3 days*		
The last part of our unit looks at how binary numbers can be added and subtracted using the 2's Complement process. This will also let us represent negative binary numbers. We'll then look at the next two logic gates: XOR and XNOR. These new gates will give us additional tools for working with MUX and DEMUX as well as circuits in general. Finaly, we'll build a circuit that can add binary numbers!		2's Complement Notes
		2's Complement Assignment
		XOR/XNOR Notes
		Multisim Binary Adders
		Binary Adders Assignment
		Take the Unit 4 Quiz!
Achievement: Recreate the Fireplace Control Circuit using new parameters		

(40 pts) Approx. 2 days

Our fifth unit in digital electronics is all about creating complex outputs from digital circuits. In doing so, we can use segmented displays like the 7-segment display to show numbers and letters. Here we'll learn about the 7-segment display, multiplexers (MUX), demultipleers (DEMUX), as well as XOR, and XNOR logic gates! We've built a good foundation for the circuit design process: our job now is to add more tools to our circuit design toolkit. This unit will expose us to a variety of these tools and will have us build a lot of simulations to illustrate how these tools work.

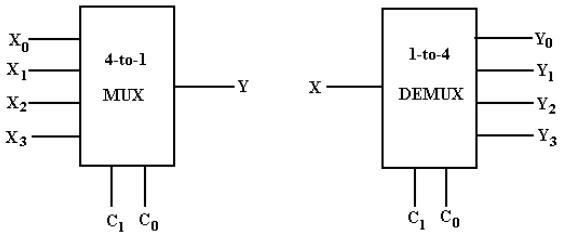
1. Start by watching the presentations *Displays Overview*, *7-Segment Displays*, and *7-Segment Display Driver*. These will give a big overview of everything we should know and understand about 7-segment displays. Take at least a full page of notes on these topics, including a map for the 7-segment display and a diagram of how the 7-segment display driver works.
2. Complete the 7-Segment Display Assignment. Make sure that you show your work as you move through the assignment!
3. Create the 7-segment display circuits in multisim and confirm that they work as intended. Use the truth tables to record your outputs based off the many possible inputs.
4. Save your completed Multisim circuits to your jump drive.
5. Have Mr. Benshoof check-off your completed circuits before you move on!



Part 1: Tasks	*10 points*	*8-6 points*	*5-0 points*
7-Segment Display Notes	+ Watch the *Displays Overview, 7-Segment Displays,* and *7-Segment Display Driver* presentations. + Take a full page of notes on these topics including details about the display and display driver pins	- Less than a full page of notes on displays - Notes are missing important parts	- Very brief or no notes in your engineering notebook
	15 points	*16-10 points*	*9-0 points*
7-Segment Displays Assignment	+ Complete the *7-Segment Displays Assignment* + You showed your work throughout the Assignment + You completed the appropriate truth tables	- Assignment incomplete - Assignment not corrected - Truth tables not complete	- Assignment missing - Assignment totally incomplete - No work shown
Multisim Circuits	+ You completed the Multisim circuit for the basic 7-segment display + You completed the Multisim circuit for the display driver	- Your simulations are not complete - Your simulations are not correct	- You only simulated 1 circuit - You did not simulate any circuits

(40 pts) Approx. 3 days

The second part of our unit focuses on Multiplexers (MUX) and Demultiplexers (DEMUX). In short, a multiplexer is a digital electronics tool (an IC chip) that takes multiple inputs and combines them into fewer outputs. The opposite is a demultiplexer that takes few (often only 1) inputs and converts them into multiple outputs. Two examples are below:



This part of the unit gives us exposure to these two tools, and then gives us some practice using mostly DEMUX in the creation of some circuits with 7-segment displays. Put together, these tools make a lot of cool things possible!

1. Start by watching all four (4) presentations on the website *MUX/DEMUX Overview, MUX/DEMUX Signals, Multiplexers,* and *Demultiplexers*. Take at least a full page of notes on these topics. You might add to these notes later as our practice circuits will use some examples of MUX/DEMUX and you could add a diagram of how those get used.
2. Complete the *MUX/DEMUX Assignment*. Build all the requested circuits in Multisim and use them to complete the corresponding truth tables. Pay extra close attention to how the MUX/DEMUX chips are helping control the attached 7-segment displays.
3. Build the necessary circuits in Multisim as part of the MUX/DEMUX Assignment. As you do so, be sure to save them to your jump drive!

Part 1: Tasks	*10 points*	*8-6 points*	*5-0 points*
MUX/DEMUX Notes	+ Watch the *MUX/DEMUX Overview, MUX/DEMUX Signals, Multiplexers, and Demultiplexers* presentations. + Take at least a full page of notes on these topics including details about how MUX and DEMUX function, and when they might be useful.	- Less than a full page of notes on MUX/DEMUX - Notes are missing important parts	- Very brief or no notes in your engineering notebook
	15 points	*16-10 points*	*9-0 points*
MUX/DEMUX Assignment	+ Complete the *MUX/DEMUX Assignment* + You showed your work where appropriate and completed the parts in your engineering notebook + You completed the appropriate truth tables	- Assignment incomplete - Nothing in your engineering notebook - Truth tables not complete	- Assignment missing - Assignment totally incomplete - No work shown
Multisim Circuits	+ You completed the Multisim circuit for the basic 7-segment display + You completed the Multisim circuit for the display driver	- Your simulations are not complete - Your simulations are not correct	- You only simulated 1 circuit - You did not simulate any circuits

(50 pts) Approx. 3 days

The final part of our unit introduces two very new things: 2's Complement Arithmetic and the XOR/XNOR logic gates. First, the 2's Complement Arithmetic will be the most confusing thing of the whole unit. This process lets us represent negative binary numbers using the standard system of all 0's and 1's. This goes on to let us do addition and subtraction with digital circuits. To do that, we'll need to explore XOR and XNOR logic gates before we can create a full binary adddding circuit.

1. Watch the *Binary Math, 2's Complement Arithmetic,* and *2's Complement Again* presentations. Together, these presentations should introduce the idea of doing math with binary numbers, and also how we can represent negative numbers in binary. Take a full page of good notes on the topic, and be sure to include examples of how that binary math can be done!
2. Complete the 2's Complement Assignment. This assignment is all just math (no circuits), and you should take your time and show all your work. The better you understand the written math here, the easier the circuits will be to understand later.
3. Watch the presentation *XOR, XNOR & Binary Adders* and take a full page of notes on the topic. Make sure that your notes include a good description of what the XOR and XNOR gates do logically, as well as how binary adders work.
4. Simulate the AOI Binary adder as well as the 74LS183 add gates circuits in Multisim
5. Use your simulated circuits to complete the Binary Adders Assignment. Make sure that you completely fill out each truth table to confirm that your circuits are working properly. Also make sure to complete the final math problems in your engineering notebook!

Part 3: Tasks	*5 points*	*4-3 points*	*2-1-0 points*
2's Complement Notes	+ Your took a full page of notes on the binary math and the 2's complement process + Your notes include some practice problems	- Your notes are missing some important parts	- Your notes are missing many parts - You took no notes
	10 points	*9-6 points*	*5-0 points*
2's Complement Assignment	+ You completed the *2's Complement Assignment* + All math problems are completed in your engineering notebook	- You did not fully complete the assignment - Some problems are missing	- The assignment is mostly incomplete - Nothing is in your engineering notebook
	5 points	*4-3 points*	*2-1-0 points*
XOR/XNOR Notes	+ Your took a full page of notes on *XOR, XNOR, and Binary Adders* + Your notes include a description of what XOR and XNOR do + Your notes discuss binary adders	- Your notes are missing some important parts	- Your notes are missing many parts - You took no notes
	10 points	*9-6 points*	*5-0 points*
Multisim Binary Adders	+ You created both binary adders in Multisim + You confirmed that they work correctly	- You only created one of the Multisim circuits	- You did not create any Multisim circuits
Binary Adders Assignment	+ You completed the assignment + All truth tables are filled out + The math problems are completed	- Your assignment is not fully complete - A part of the assignment is missing	- You missed many parts of the assignment - The assignment is totally missing
Take the Unit 4 Quiz!	+ You took the Unit 4 Quiz before the due date + Your grade is based on the number correct	N/A	- You did not take the Unit 4 Quiz by the due date