Unit 2.3: Specific Combinational Logic Designs

Content Area: **Science**
Course(s): **Digital Electro**
Time Period: **Semester 1**
Length: **4 weeks**
Status: **Published**

Standards

TEC.9-12.8.1.12.A.1	Construct a spreadsheet, enter data, and use mathematical or logical functions to manipulate data, generate charts and graphs and interpret the results.
TEC.9-12.8.2.12.F.2	Explain how material science impacts the quality of products.
TEC.9-12.8.2.12.F.3	Select and utilize resources that have been modified by digital tools in the creation of a technological product or system (CNC equipment, CAD software).
TEC.9-12.8.2.12.G.1	Analyze the interactions among various technologies and collaborate to create a product or system demonstrating their interactivity.
	Information literacy skills, research, data analysis and prediction are the basis for the effective design of technology systems.
	The designed world is the product of a design process that provides the means to convert resources into products and systems.
	Technology is created through the application and appropriate use of technological resources.

Enduring Understandings

Understandings

Students will understand that …

1. The relationship of hexadecimal and octal number systems to the decimal number system is important in digital electronics. Those who work in digital electronics must be able to convert number systems.
2. The addition of two binary numbers of any bit length can be accomplished by cascading one half-adder with one or more full adders.
3. Two's complement arithmetic is the most commonly used method for handling negative numbers in digital electronics.
4. XOR and XNOR gates can be used to implement combinational logic circuits, but their primary intended purpose is for implementing binary adder circuits.
5. Seven-segment displays are used to display the digits 0-9 as well as some alpha characters.
6. The two varieties of seven-segment displays are common cathode and common anode.
7. Multiplexer/de-multiplexer pairs are most frequently used when a single connection must be shared between multiple inputs and multiple outputs.
8. Electronics displays that use multiple seven-segment display utilize de-multiplexers to significantly reduce the amount of power required to operate the display.
9. A formal design process exists for translating a set of design specifications into a functional combinational logic circuit.
10. Any combinational logic expression can be implemented with AOI, NAND, or NOR logic.
11. The electrical propoerties of insulators, conductors, and semiconductors are based on the atomic structure of these materials.
12. The properties of semiconductors are modified by the process of adding impurities, known as doping.
13. When N-Type and P-Type semiconductors form a junction the junction behaves as a diode, only allowing current to flow in one direction.
14. Semoconductors can be made from many elements or compounds and the choice of material is based on practical considerations, such as the number of majority/minority carries, temperature properties, etc.

Essential Questions

Students will keep considering …

1. Why is the understanding of number systems and conversion between number systems such as binary, octal, decimal, hexadecimal, and Binary Coded Decimal (BCD) essential to your ability to design combinational logic circuits?
2. Why are binary adders such an important design in digital electronics and how do they work?
3. How can different types of seven-segment displays be integrated into your designs?
4. How would you use a design process to convert a set of design specifications that you have defined into a functional combinational logic circuit containing multiple outputs?
5. What is the basic operation of digital multiplexers and de-multiplexers and how can they improve a circuit's design?

Knowledge and Skills

Knowledge

Students will …

1. Know the rules governing base 10 number systems.
2. Know the rules governing base 8 number systems.
3. Know the rules governing base 16 number systems.
4. Know the rules governing two's complement addition.
5. Recognize a half-adder.
6. Recognize a full-adder.
7. Label the seven segments of a seven-segment display.
8. Identify Common Cathode and Common Anode Seven Segment Displays and know the characteristics of each.
9. Know the formal design process used to translate design specifications to a functional combinational logic circuit.
10. Recognize a multiplexer and de-multiplexer.
11. Describe the benefits of using a multiplexer and de-multiplexer in a circuit design.
12. Describe the operation of semiconductors based on their atomic structure.
13. Describe the operation of a diode.

Skills

Students will …

1. Convert numbers between the hexadecimal or octal number systems and the decimal number system.
2. Use a seven-segment display in a combinational logic design to display alpha/numeric values.
3. Select the correct current limiting resistor and properly wire both common cathode and common anode seven-segment displays.
4. Design binary half-adders and full-adders using XOR and XNOR gates.
5. Use the two's complement process to add and subtract binary numbers.
6. Describe how the addition of two binary numbers of any bit length can be accomplished by cascading one half-adder with one or more full adders.
7. Design and implement binary adders using SSI and MSI ICs.
8. Use a formal design process to translate a set of design specifications for a design containing multiple outputs into a functional combinational logic circuit.
9. Design AOI, NAND, and NOR solutions for a logic expression and select the solution that uses the least number of ICs to

implement.

10. Design electronics displays using seven-segment displays that utilize de-multiplexers.
11. Use Circuit Design Software (CDS) and a Digital Logic Board (DLB) to simulate and prototype specific combinational logic circuits.

Resources

Technology Resources

- National Instruments Multiim circuit design and simulation software
- Microsoft Office Applications

Electronics Resources

- Electronics Trainers (power supply, function generator, breadboard)
- Electronics hand tools (diagonal cutters, needle-nosed pliers, wire strippers, etc.)
- Digital Multimeters
- Digital Transistor-Transistor Logic (TTL) integrated circuits
- TTL Chip Checker

Modifications

https://docs.google.com/document/d/1ODqaPP69YkcFiyG72fIT8XsUIe3K1VSG7nxuc4CpCec/edit?usp=sharing

Assessments

https://docs.google.com/document/d/1wR7bQF-8AQoRrt0g4C3hKja0yjwDjC9_BiAmONWbTcI/edit?usp=sharing