PROJECT LEAD THE WAY PLTW

Curriculum Framework – Digital Electronics (2015-2016)
Unit 2 Combinational Logic – Lesson 2.3 Specific Combinational Logic Designs

Desired Results *(stage 1)*

ESTABLISHED GOALS
It is expected that students will…

- G1 – Demonstrate an ability to identify, formulate, and solve engineering problems.
- G2 – Demonstrate an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- G3 – Demonstrate an ability to design and conduct experiments, as well as to analyze and interpret data.
- G4 – Demonstrate an ability to apply knowledge of mathematics, science, and engineering.
- G5 – Demonstrate an ability to use the techniques, skills,

Transfer

TRANSFER: *Students will be able to independently use their learning to …*

- T1 – Apply number system conversions as they relate to digital circuit design.
- T2 – Incorporate seven segment displays into circuit designs.
- T3 – Recognize and describe common digital circuits design and explain how they are used in common electronic devices. (Binary Adders; Multiplexers/De-Multiplexers)
- T4 – Add and subtract numbers using two's compliment arithmetic and apply this apply this concept in the design of a binary adder.
- T5 – Design and create a digital circuit with designer-defined outputs.

Meaning

UNDERSTANDINGS: *Students will understand that …*

- U1 – 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.
- U2 – The addition of two binary numbers of any bit length can be accomplished by cascading one half-adder with one or more full adders.
- U3 – Two's complement arithmetic is the most commonly used method for handling negative numbers in digital electronics.
- U4 – XOR and XNOR gates can be used to implement combinational logic circuits, but their primary intended

ESSENTIAL QUESTIONS: *Students will keep considering …*

- Q1 – 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?
- Q2 – Why are binary adders such an important design in digital electronics and how do they work?
- Q3 – How can different types of seven segment displays ne integrated into your designs?
- Q3 – 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

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and modern engineering tools necessary for engineering practice.

- G6 – Pursue the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
- G7 – Demonstrate an understanding of professional and ethical responsibility.
- G8 – Demonstrate an ability to function on multidisciplinary teams.
- G9 – Demonstrate an ability to communicate effectively.
- G10 – Gain knowledge of contemporary issues.
- G11 – Recognize the need for, and develop an ability to engage in life-long learning.

purpose is for implementing binary adder circuits.

- U5 – Seven-segment displays are used to display the digits 0-9 as well as some alpha characters.
- U6 – The two varieties of seven-segment displays are common cathode and common anode.
- U7 – Multiplexer/de-multiplexer pairs are most frequently used when a single connection must be shared between multiple inputs and multiple outputs.
- U8 – Electronics displays that use multiple seven-segment display utilize de-multiplexers to significantly reduce the amount of power required to operate the display.
- U9 – A formal design process exists for translating a set of design specifications into a functional combinational logic circuit.
- U10 – Any combinational logic expression can be implemented with AOI, NAND, or NOR logic.

outputs?

- Q4 – What is the basic operation of digital multiplexers and de-multiplexers and how can they improve a circuits design?

Acquisition

KNOWLEDGE: *Students will…*

- K1 – Know the rules governing base 10 number systems.U1
- K2 – Know the rules governing base 8 number systems.U1
- K3 – Know the rules governing base 16 number systems.U1
- K4 – Know the rules governing two's complement addition.U3
- K5 – Recognize a half-adder.U2,U3,U4
- K6 – Recognize a full-adder. U2,U3,U4
- K7– Label the seven segments of a seven segment

SKILLS: *Students will…*

- S1 – Convert numbers between the hexadecimal or octal number systems and the decimal number system.U1
- S2 – Use a seven-segment display in a combinational logic design to display alpha/numeric values.U5,U6
- S3 – Select the correct current limiting resistor and properly wire both common cathode and common anode seven-segment displays.U5,U6
- S4 – Design binary half-adders and full-adders using XOR and XNOR gates.U2,U3,U4
- S5 – Use the two's complement process to add and subtract binary numbers.U3

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	display.(U5,U6) • K8 – Identify Common Cathode and Common Anode Seven Segment Displays and know the characteristics of each.U5,U6 • K9 – Know the formal design process used to translate design specifications to a functional combinational logic circuit.U9 • K10 – Recognize a multiplexer and de-multiplexer.U7,U8 • K11 – Describe the benefits of using a multiplexer and de-multiplexer in a circuit design.U7,U8	• S6 – 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.U2 • S7 – Design and implement binary adders using SSI and MSI ICs.U2,U3,U4 • S8 – Use a formal design process to translate a set of design specifications for a design containing multiple outputs into a functional combinational logic circuit.U9 • S9 – Design AOI, NAND, & NOR solutions for a logic expression and select the solution that uses the least number of ICs to implement.U9,U10 • S10 – Design electronics displays using seven-segment displays that utilize de-multiplexers.U7,U8 • S11 – Use Circuit Design Software (CDS) and a Digital Logic Board (DLB) to simulate and prototype specific combinational logic circuits.U9,U10

Evidence *(stage 2)*		
Activities (A) Projects (P) Problems(B)	Assessment FOR Learning	Assessment OF Learning
2.3.1.A Hexadecimal and Octal Number Systems	• Student responses to examples in presentation 2.3.1 Hexadecimal and Octal Number Systems • Essential Questions	• Successful completion of conversions (25) • Conclusion Questions
2.3.2.A Seven Segment Displays	• Student responses to examples in 2.3.2 Seven Segment Displays. • Essential Questions	• Print out of simulated circuits • Conclusion Questions
2.3.3.A Multiplexors and De-Multiplexors	• Essential Questions	• Print out of simulated circuits • Conclusion Questions
2.3.3.A Binary Addition: Two's Compliment Arithmetic	• Student responses to examples in presentation 2.3.3 Binary Addition: Two's Compliment Arithmetic • Essential Questions	• Successful completion of calculations (18) • Conclusion Questions
2.3.4.A Binary Adders: XOR and XNOR	• Essential Questions	• Print out of simulated circuits • Conclusion Questions

Learning Plan *(stage 3)*	
Activities (A) Projects (P) Problems(B)	Knowledge and Skills
2.3.1.A Hexadecimal and Octal Number Systems	K1,K2,K3,S1
2.3.2.A Seven Segment Displays	K7,K8,K11,S2,S3,S10
2.3.3.A Multiplexors and De-Multiplexors	K7,K8,K10,K11,S2,S3,S10,S11
2.3.3.A Binary Addition: Two's Compliment Arithmetic	K4,S5
2.3.4.A Binary Adders: XOR and XNOR	K4,K5,K6,S4,S5,S6,S7

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