Digital Electronics

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Digital Electronics

Content	Skills	Learning Targets	Standards	Assessment	Resources & Technology
CEQ: **WHAT MAKES DIGITAL ELECTRONICS SO IMPORTANT TO OUR SOCIETY?** **UEQ:** **What are the Foundations to digital electronics?** **A. Safety in Electronics** **B.Scientific, engineering and Systems International (SI) notation**	A. Illustrate proper safety while working with electronics. B. Differentiate numbers in scientific notation, engineering notation, and System International (SI) notation. B. Create numbers in scientific notation, engineering notation, and System International (SI) notation. C.Define resistor's nominal value via	A. I can list five basic safety rules for electronics. B. I can properly display large and small numbers in proper notation, C. I can read resistor values		A. CFA-Safety quiz - Activity 1.1.1 B. CSA-Scientific and Engineering notation - Activity 1.1.2	PLTW Curriculum Digital Electronics (DE)

C. Resistor color code, and how is it used to identify and select resistors **D. What is the labeling nomenclature for capacitors, and how is it used to identify and select capacitors?** **E.** Soldering **UEQ: What is Analog Electronics?** **A. Analog vs. digital signals**	reading color bands. C. Apply Digital Multimeter to resistor to determine resistor's actual value. D. Describe many of the common components used in electronics. D. Identify many of the common components used in electronics. D. Define capacitor's nominal value via reading its nomenclature. E. Create a properly tin the tip of a soldering iron. E. Apply proper soldering and de-soldering techniques. A, Illustrate sine waves for analog and digital signals.	via color bands on resistor. C. I can read resistor values using a multimeter, D. I can describe and identify ten different common components used in electronics. D. I can read values of any capacitor. E. I can prepare and safely use a soldering iron to assemble an electronic project. E. I can clean up a poor solder joint by using de-soldering techniques.		C. -D. CSA-Compo nent Identification - Activity 1.1.3 E. CSA- Solderi ng and De-soldering- A ctivity 1.1.4	PLTW Curriculum Digital Electronics (DE)

B. What are the voltage levels associated with digital signals? **C. What is the voltage range of an analog signal?** **D. What determines whether a material is a conductor, an insulator, or a semiconductor?** **E. What is the relationship between voltage, current, and resistance in an electrical circuit?** **F. What is true about the sum of all voltages around a closed path in an electrical circuit?** **G. What is a breadboard, and what is it used for?**	B.-C. Be able to determine the amplitude, period, frequency, and duty cycle analog and digital signals. D. Be able to identify the parts of an atom and determine if an element would make a good conductor, insulator, or semiconductor. E. Use Ohm's Law, Kirchhoff's Voltage Law, and Kirchhoff's Current Law to solve for simple series and parallel circuit. F. Be able to use a Circuit Design Software (CDS) to analyze simple analog circuits.	A. I can draw, re-draw and label the differences between analog and digital sine waves. B. I can label a sine wave diagram with proper digital voltage. C. I can label a sine wave diagram with proper analog voltage. D. I can label the parts of an atom and the outer rings E. I can solve math problems related to Ohm's Law, Kirchhoff's Voltage Law, and Kirchhoff's Current Law. F. I can demonstrate proper use of CDS for analog circuits. G. I can build a curcuit		A.CSA- Analog and DIgital signals -Activity 1.2.5 B. CSA-555 timers- Activity 1.2.6 C.CSA- Board game counter - Activity 1.2.7 D. CSA-Electro n Theory - Activity 1.2.1 E. CSA-Circuit Theory- Activity 1.2.2	

	G. Be able to use a breadboard and digital multimeter to analyze simple analog circuits.	on a breadboard and analyze it using a multimeter.		F. CSA- Circuit Theory-simulati on -Activity 1.2.3 G. CSA-Circuit Theory-breadbo arding -Activity 1.2.4	

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UEQ: What is **Digital Electronics** **A. What information is contained in a manufacturer datasheet for logic gates?**	A. Be able to obtain and extract information from the manufacturer datasheets for components commonly used in digital electronics.	A. I can locate and read datasheet information for required components. B. I can locate and utilize	A. CSA- Intro to Logic and datasheets- Activity 1.3.4 B.-E CSA-Combinational	PLTW Curriculum Digital Electronics (DE)

B. What are the three characteristics that categorize integrated circuits? **C. What are the available Transistor-Transistor Logic sub-families?** **D. What are the three ways to depict any logic gate?** **E. What are the outputs of combinational logic a function of?** **F. What is AOI logic?** **G. What are the outputs of sequential logic a function of?** **H. What is the fundamental building block of sequential logic?**	B.Know how to identify commonly used electronic components given their part number or schematic symbol. C. -D . Be able to identify various integrated circuit (IC) package styles. E. Know the fundamental differences between combinational and sequential logic. F. Identify and describe the function of AND, OR, & Inverter gates. G.-H. Identify and describe the function of a D flip-flop.	electronic components when working in CDS or with a breadboard. C.- D. I can describe a component so others can identify their package. E. I can list 5 ways combinational and sequential are different. F. I can create a circuit utilizing AOI logic components. G-H. I can create a circuit utilizing a D Flip-flop I. I can utilize the CDS to	Logic- Activity 1.3.1 F. CSA-Board Game Counter- Activity 1.3.3 G.-H. CSA-Sequential Logic - Activity 1.3.2 I. CFA-Board Game Counter- Activity 1.3.3	

I. What are the steps for troubleshooting digital electronics circuits?	I. Be able to use Circuit Design Software (CDS) to simulate and test a simple sequential logic circuit design with D flip-flops.	design, draw, simulate and test sequential and combinational logic.		PLTW Curriculum Digital Electronics (DE)
UEQ: What is **AOI Logic**	I. Utilize the Circuit Design Software (CDS) to simulate and test a complete design containing both combinational and sequential logic.	A. I can convert any binary or decimal number to its complement.	A.CSA- Binary Numbers and Conversions- Activity 2.1.2	
A. What are the processes for converting numbers between the binary and decimal number systems, and why is the understanding of these two numbers systems essential to your ability to design combinational logic circuits?	A. Convert numbers between the binary and decimal number systems.	B. I can design a circuit using truth tables and logic expressions.	B. CSA- Truth Tables and Conversions- Activity 2.1.3	
B. What is the relationship between a combinational logic design's truth table, logic expression, and circuit implementation?.	B. Translate design specifications into truth tables.		C. CSA-Boolean Algebra- Activity 2.1.6 C. CSA-DeMorgan	

C. When you simplify a logic expression using Boolean algebra, how do you know that you have the simplest solution and that the solution is correct? **D. In terms of circuit implementation, what is the advantage of representing all logic expression in either the SOP or POS form?** **E. Defend the following statement: *"All logic expression, regardless of complexity, can be implemented with AND, OR, & Inverter Gates."*** **F. What are the steps in the design process of converting a set of design specifications into a functional combinational logic circuit?**	B. Extract un-simplified logic expressions from truth tables. B. Construct truth tables from logic expressions. C Use the rules and laws of Boolean algebra, including DeMorgan's, to simplify logic expressions. D. Analyze AOI (AND/OR/Invert) combinational logic circuits to determine their equivalent logic expressions and truth tables. E. Design combinational logic circuits using AOI logic gates. E, Translate a set of design specifications into a	C. I can simplify logic expressions utilizing Boolean Algebra and DeMorgan's Theroems. D. I can view a circuit and determine it's logic expression. E.I can design a circuit uitizing AOI logic. F . I can design a proper circuit for a given word problem.	Thereoms- Activity 2.1.7 D. CSA- OI Logic Implementation- Activity 2.1.5 E.CSA- AOI Logic Analysis- Activity 2.1.4 F. CFA-Majority Vote Project - 2.1.1	

	functional AOI combinational logic circuit following a formal design process. F. Use Circuit Design Software (CDS) and a Digital Logic Board (DLB) to simulate and prototype AOI logic circuits			

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Content	Skills	Learning Targets	Assessment	Resources & Technology
UEQ: What is NAND and NOR Logic A. What is the process for using the K-Mapping technique to simplify a logic expression? What are the advantages of using this process over Boolean algebra? B. What is a *don't care* condition, and how can it be used in a K-Map to reduce the complexity of	A. Apply Karnaugh Mapping technique to simplify combinational logic problems with less than four inputs. B. Solve Karnaugh Mapping that involves "don't care" condition(s).	A. -B. I can K-map a truth table to derive a simplified logic expression.	A-B. CSA- K-Mapping - Activity 2.2.1	PLTW Curriculum Digital Electronics (DE)

the combinational logic design? C. What does the term universal gate mean? Why are NAND gates and NOR gates considered universal gates? D. What is the advantage of implementing a combinational logic design with only NAND gates (or NOR gates)? E. What are the steps in the design process for converting an AOI combinational logic design into a NAND only or NOR only design? F. Typically, what is the advantage of NAND only design (or NOR only design) over an AOI design? Why is it important to it compare both the NAND only and NOR only designs?	C. Design combinational logic circuit using NAND gates. D. Design combinational logic circuit using NOR gates. E.-F. Construct NAND logic circuit prototypes using Circuit Design Software and a Digital Logic Board. E.-F. Construct NOR logic circuit prototypes using circuit Design Software and a Digital Logic Board.	C. I can describe and create a circuit utilizing NAND gates D. I can describe and create a circuit utilizing NAND gates E.-F. I can create circuits in CDS to demonstrate proper use of NAND and NOR gates. A. I can design a circuit	C.CSA- NAND Logic Design - Activity 2.2.2 D. CSA-NOR Logic Design - Activity 2.2.3 E.CSA-Logic Converter - Activity 2.2.4 F.CFA- Fireplace Control Circuit - Activity 2.2.5 A. CSA- even Segment Display - Activity 2.3.1	PLTW Curriculum Digital Electronics (DE)

F. Date of Birth Design A.. What is the hrefationship between the resistor value used, the amount of current flowing, and the brightness of a segment of seven-segment display. B. Why is it more difficult to design logic circuits with NAND logic or NOR logic than it is with straightforward AOI logic, in terms of circuit implementation. C. Why does a logic expression require fewer ICs to implement if NAND logic or NOR logic is used than would be required if AOI logic were used. D. What are the steps in the design process of converting a set of design specifications, containing	A. Use a seven-segment display in a combinational logic design to display alpha/numeric values. B Select the correct current limiting resistor and properly wire both common cathode and common anode seven-segment displays. C Follow a formal design process to translate a set of design specifications for a design containing multiple outputs into a functional combinational logic circuit.	utilizing a seven segment display.	B-E. CFA-Date of Birth project- Activity 2.3.2	

multiple outputs, into a functional combinational logic circuit? E. When compared to a design with a single output, is the process different for multiple outputs?	D Design AOI, NAND, & NOR solutions for a logic expression and select the solution that uses the least number of ICs to implement. E Use Circuit Design Software (CDS) and Digital Logic Board (DLB) to simulate and prototype AOI, NAND, & NOR logic circuits.			

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Content	Skills	Learning Targets	Assessment	Resources & Technology
G. Specific Comb Logic Circuits & Misc. Topics A. What are the processes for converting numbers between the hexadecimal or octal and decimal number systems, and why is the understanding of these two numbers systems important to your	A. Convert numbers between the hexadecimal or octal number systems and the decimal number system.	A. I can convert any octal, hex or decimal number to it's complement.	A. CSA- Octal/Hex numbers- Activity 2.4.1	PLTW Curriculum Digital Electronics (DE)

comprehension of digital electronics? B. In terms of circuit complexity, what is the advantage of implementing binary half and full adders with XOR gates over other logic gates? C. 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. D. What is the basic operation of digital multiplexers and de-multiplexers? E. Explain how digital de-multiplexers are used to significantly reduce the amount of power required to operate the electronics displays that use multiple seven-segment display. F. What are the steps in the two's complement	B. Use XOR and XNOR gates to design binary half-adders and full-adders. C. Use SSI and MSI gates to design and implement binary adders. D.-E. Design electronics displays using seven-segment displays that utilize de-multiplexers. F. Use the two's complement process to add and subtract binary numbers.	B. I can design a half or full adder circuit using XOR and XNOR gates. C. I can design binary adder circuits using SSI and MSI gates. D.-E. I can design a seven display circuit utilizing a demultiplexer. F. I can add and subtract any two binary numbers using the two's complement process.	B.-C. CSA- XOR/XNOR Binary adders- Activity 2.4.2 D.-E. CSA- ultiplexer/DeM ultiplexer- Activity 2.4.4 F. CSA- wo Complement arithmetic- Activity 2.4.3	

process for adding or subtracting two binary numbers? **H. Programmable Logic – Combinational** A. What is the design process for using a Circuit Design Software to enter and synthesize combinational logic into a programmable logic device? B. Describe how programmable logic devices can be used to implement combinational logic circuits. C. List the advantages and disadvantages of using a programmable logic device over discrete logic gates. D. Why are programmable logic devices best suited	A. Use Circuit Design Software (CDS) and a Digital Logic Board (DLB) to simulate and prototype specific combinational logic circuits. B. Design combinational logic circuits using a programmable logic device. C. Be able to cite the advantages and disadvantages of programmable logic devices over discrete logic gates. D. Use Circuit Design Software (CDS) and a Digital Logic Board (DLB) to simulate and prototype combinational logic	A. I can use CDS and DLB to successfully design combinational logic circuits. B. I can program a FPGA (Field Programmable Graphic Array) board with a combinational logic circuit. C. I can list 5 advantages and 5 disadvantages for using an FPGA board. D. I can program the FPGA by creating a circuit in CDS.	A.-D. CSA- Programming Tutorial- Activity 2.5.1 A.-D. CFA-Date of Birth - PLD- Activity 2.5.2 A.-D. CFA-Copy Jam Detector- Activity 2.5.3	PLTW Curriculum Digital Electronics (DE)

for larger, more complex designs?	designs implemented with programmable logic.			

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I. Latches & Flip-Flops A. What is the basic function of a flip-flop and transparent latch? B. What functions do the synchronous and	A. Know the schematic symbols and excitation tables for the D and J/K flip-flops.	A. I can draw 5 schematic symbols and match them to their excitation table. B. I can list three functions	A. CSA- Introduction to Flip-Flops- Activity 3.1.1	PLTW Curriculum Digital Electronics (DE)

asynchronous inputs serve on flip-flops and transparent latches?	B. Describe the function of the D and J/K flip-flops. B. Describe the function of, and differences between, level sensitive and edge sensitive triggers. B. Describe the function of, and differences between, active high and active low signals. B. Describe the function of, and differences between, a flip-flop's synchronous and asynchronous inputs.	of each D and J-K flip-flop B. I can list three examples of level sensitive and edge sensitive triggers of each D and J-K flip-flop B. I can list three differences between, active high and active low signals of each D and J-K flip-flop B. I can list three differences between synchronous and asynchronous inputs of each D and J-K flip-flop	B.-C. CSA- Flip-Flops applications- Activity 3.1.2	
C. What are some of the typical applications of flip-flops?	B. Draw detailed timing diagrams for the D or J/K flip-flop's Q output in response to a variety of synchronous and asynchronous input conditions.	B. I can draw a timing diagram of each D and J-K flip-flop		
J. Asynchronous Counter	C. Analyze and design introductory flip-flop applications such as event detection circuits, data	C. I can design a circuit for each of these four, event detection circuits, data synchronizers, shift registers, and frequency dividers.		

A. Asynchronous counters, also called ripple counters, are characterized by an external signal clocking the first flip-flop. All subsequent flip-flips are clocked by the output of the previous flip-flop. B. Asynchronous counters can be implemented using small scale integrated (SSI) and medium scale integrated (MSI) logic gates. C. Asynchronous counters can be implemented with either D or J/K flip-flops. D. Up counters, down counters, and modulus counters all can be implemented using the asynchronous counter method.	synchronizers, shift registers, and frequency dividers. C. Use Circuit Design Software (CDS) and a Digital Logic Board (DLB) to simulate and prototype introductory flip-flop applications. A. Know the advantages and disadvantage of counters designed using the asynchronous counter method. B. Be able to describe the ripple effect of an asynchronous counter. C. Be able to analyze and design up, down and modulus asynchronous	C. I can print out the circuit and simulation for flip-flop applications using the CDS. A. I can list 5 advantages and disadvantages of asynchronous counters. B. I can draw how the asynchronous counter is affected by ripple effect. C. I can design any mod counter up to four bit using D or J-K flip-flops. D. . I can design any mod counter up to four bit using MS I circuit counters.	A.CSA- SSI Asynchronous counters - Activity 3.2.1 B.CSA- SSI Asynchronous Modulus counters - Activity 3.2.2 C.CSA- PLD Asynchronous counters - Activity 3.2.3 D. CSA- SI Asynchronous counters - Activity 3.2.4 A-D. CFA-60 second timer - Project 3.2.4	PLTW Curriculum Digital Electronics (DE)

K. Synchronous Counters A. What is another name for synchronous counters? B. How are the clock inputs of a synchronous counter's flip-flops connected? C. What is the process for designing synchronous counters implemented using discrete D and J/K flip-flops and medium scale integrated (MSI) circuit counters? D. What are the differences between a synchronous counter and a synchronous modulus counter? E. What is the process for designing up, down, and modulus synchronous counters?	counters using discrete D and J/K flip-flops. D. Be able to analyze and design up, down and modulus asynchronous counters using medium scale integrated (MSI) circuit counters. D. Use Circuit Design Software (CDS) and Digital Logic Board (DLB) to simulate and prototype SSI and MSI asynchronous counters. A. Know the advantages and disadvantage of counters designed using the synchronous counter method. B. Be able to analyze and design up, down and modulus synchronous	D. I can design in CDS and then build a project on a proto board a complex counter using MSI components. A. A. I can list 5 advantages and disadvantages of synchronous counters. B. I can draw how the synchronous counter uses D and J-K flip-flops. C.- D. I can design any mod counter up to four bit using MS I circuit counters.	A.-B. CSA- SSI Synchronous counters - Activity 3.3.1 A.-B. CSA- MSI 163 Synchronous counters - Activity 3.3.2 C.-D CSA- MSI 193 Asynchronous counters - Activity 3.3.3 A.-E. CFA- Now Serving - Project 3.3.3	

	counters using discrete D and J/K flip-flops. C.-D. Be able to analyze and design up, down and modulus synchronous counters using medium scale integrated (MSI) circuit counters. E. Use Circuit Design Software (CDS) and Digital Logic Board (DLB) to simulate and prototype SSI and MSI synchronous counters.	E. I can design in CDS and then build a project on a proto board a complex counter using MSI components.		

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Content	Skills	Learning Targets	Assessment	Resources & Technology
Introduction to State-Machine Design	A. Be able to describe the	A. I can list 5 components	A. CSA-State Machine	

A. What is the basic function of a state machine? B. What are some common everyday devices that are controlled by state machines? C. What are the two variations of state machine design, and what are the advantages of each. D. What type of logic gates are used to implement state machines?	components of a state machine. A. Be able to draw a state graph and construct a state transition table for a state machine. B. List common everyday devices that are controlled by state machines C. Describe the two variations of state machines and list the advantages of each. D. Be able to derive a state machine's Boolean equations from its state transition table. D. Be able to implement Boolean equations into a functional state machine. D. Use Circuit Design Software (CDS) and a Digital Logic Board (DLB) to simulate and prototype	of a state machine. A. I can draw a state graph and construct it's corresponding transition table. B. I can list 5 devices used daily that are controlled by state machines. C. I can describe the two variations of state machines and list the advantages of each. D. I can use a state transition table to derive a machines Boolean equation. D. I can design a functional state machine. D. I can use CDS to design a state machine.	design- Activity 3.4.1 B.-D. CSA-elevator door state machine- Activity 3.4.2 A. CSA- Microcontoller	PLTW Curriculum Digital Electronics (DE)

Introduction to Microcontrollers A. What is a microcontroller? B. What is BASIC? C. What are the different types of loops and how are they used? D. What is the purpose of declaring variables? E. How are variables used in programming? F. What is syntax and why is it important to know? **Microcontrollers and the Boe-Bot** A. What is a servo motor and what parameters does it use in programming code?	state machines designs implemented with discrete and programmable logic. A. Use the Board of Education (BOE) to write programs B. Create a program that utilizes the Debug screen C. Create programs that use various loops D.-E. Create programs that use variables F. Create programs that use inputs and outputs	A. I can use the BOE to write programs. B. I can demonstrate proper use of Debug command. C. I can create loops in programming. D.-E. I can use variables in programming. F. I can use inputs and outputs in programming. A. I can program a servo	and the BOE- Activity 4.1.1 A.-F. CSA-Microcontoller Output- Activity 4.1.2 A.-F..CSA- Microcontoller Input- Activity 4.1.3 A. CSA- assemble and test the BOE- Activity 4.2.1 B.CSA-BOE navigation- Activity 4.2.2 B. CSA-BOE tactile whiskers- Activity 4.2.3	PLTW Curriculum Digital Electronics (DE)

B. What is a tactile switch and how is it used to create an autonomous robot? **Boe-Bot Design Projects** A. How does a microcontroller enable users to interface the analog world with the digital world? B. How does the design course relate to real-world problems?	A. Program a servo motor. B. Program and test an autonomous robot. B. Use mathematics to calculate programming values A. Draw a flowchart for a microcontroller program that will be used to maneuver a robot. B. Program a microcontroller to maneuver a robot through a design course.	motor. B. I can program and test an autonomous robot. B. I can solve math problems to assist programming the BOE. A. I can draw a flowchart for a microcontroller program B. I can program a microcontroller to maneuver a robot through a design course.	A.CFA- BOE-bot design project-	