Digital Electronics					
Course					
Digital Electronics TM is the study of electronic circuits that are used to process and control digital signals. In contrast to analog electronics, where information is represented by a continuously varying voltage, digital signals are represented by two discreet voltages or logic levels. This distinction allows for greater signal speed and storage capabilities and has revolutionized the world electronics. Digital electronics is the foundation of all modern electronic devices such as cellular phones, MP3 players, laptop computers, digital cameras, high definition televisions, etc. The major focus of the DE course is to expose students to the design process of combinational and sequential logic design, teamwork, communication methods, engineering standards, and technical documentation. Utilizing the activity-project-problem-based (APPB) teaching and learning pedagogy, students will analyze, design and build digital electronic circuits. While implementing these designs students will continually hone their interpersonal skills, creative abilities and understanding of the design process. Digital Electronics TM (DE) is a high school level course that is appropriate for 10th or 11th grade students interested in electronics. Other than their concurrent enrollment in college preparatory mathematics and science courses, this course assumes no previous knowledge.					
Program of Study to which the course applies	**Course Code**				
STEM:	100403				
	Course Content	**Reference Standards**	**Crosswalk to Common Core Standards**	**Crosswalk to Nebraska Standards**	**Comments**
Standard 1	Students will understand and apply fundamentals of Analog and Digital Electronics.	PLTW-DE			
Benchmark 1.1	Recognize safety is an important concept that must be considered for the safety of the individual, class, and overall environment of the classroom/laboratory.	PLTW-DE			

Performance Indicator 1.1.1	Know and practice proper safety while working with electronics.	PLTW-DE			
Benchmark 1.2	Understand that electricity, even at the nominal levels used in this curriculum, can cause bodily harm or even death.	PLTW-DE			
Performance Indicator 1.2.1	Know and practice proper safety while working with electronics.	PLTW-DE			
Benchmark 1.3	Use scientific notation, engineering notation, and Systems International (SI) notation to conveniently write very large or very small numbers frequently encountered when working with electronics.	PLTW-DE		MA.12.1.3.c SC.12.1.1.l	
Performance Indicator 1.3.1	Express numbers in scientific notation, engineering notation, and System International (SI) notation.	PLTW-DE			
Benchmark 1.4	Use an accepted industry standard to label the nominal value of resistors and capacitors.	PLTW-DE	ELA.RST.11-12.3	LA.12.1.6.k LA.12.3.2	Alignment presumes that students must comprehend oral or written instructions to complete the task (CC: ELA.RST.11-12.3; NE: LA.12.1.6.k, LA.12.3.2).
Performance Indicator 1.4.1	Identify many of the common components used in electronics.	PLTW-DE			

Performance Indicator 1.4.2	Be able to determine a resistor's nominal value by reading its color code.	PLTW-DE			
Performance Indicator 1.4.3	Be able to determine a resistor's actual value by reading its resistance with a Digital Multimeter (DMM).	PLTW-DE			
Performance Indicator 1.4.4	Be able to determine a capacitor's nominal value by reading its labeled nomenclature.	PLTW-DE			
Benchmark 1.5	Describe soldering as the process of joining two metal surfaces together to form an electrical connection. Soldering is used extensively in the assembly of electronic components.	PLTW-DE	ELA.WHST.11-12.2.b ELA.SL.11-12.4	LA.12.2.1.b LA.12.3.1.a	When students *describe* information or ideas, they communicate their knowledge through either speaking or writing. To demonstrate full knowledge on the topic, students' presentations must include all the main ideas and relevant details on the subject (CC: ELA.WHST.11-12.2.b, ELA.SL.11-12.4; NE: LA.12.2.1.b, LA.12.3.1.a).
Performance Indicator 1.5.1	Be able to properly tin the tip of a soldering iron.	PLTW-DE			
Benchmark 1.6	Solder electronic components properly and recognize improper solder connections.	PLTW-DE	ELA.RST.11-12.3	LA.12.1.6.k LA.12.3.2	Alignment presumes that students must comprehend oral or written instructions to complete the task (CC: ELA.RST.11-12.3; NE: LA.12.1.6.k, LA.12.3.2).
Performance Indicator 1.6.1	Use proper soldering/de-soldering techniques to solder and de-solder components on a printed circuit boards.	PLTW-DE			
Standard 2	Students will be introduced to Analog Electronics and demonstrate a basic understanding of those concepts.	PLTW-DE			

Benchmark 2.1	Distinguish between analog and digital signals.	PLTW-DE			
Performance Indicator 2.1.1	Be able to determine the amplitude, period, frequency, and duty cycle of analog and digital signals.	PLTW-DE			
Benchmark 2.2	Understand digital signals have two well-defined voltage levels, one for a logic high and one for a logic low.=	PLTW-DE			
Performance Indicator 2.2.1	Measure digital voltage levels with a multimeter.	PLTW-DE			
Performance Indicator 2.2.2	Display a digital waveform using an oscilloscope.	PLTW-DE			
Benchmark 2.3	Comprehend analog signals have an infinite number of voltage levels that vary continuously over the voltage range for that particular system.	PLTW-DE			
Performance Indicator 2.3.1	Measure voltage levels of a sine wave using an oscilloscope.	PLTW-DE			
Benchmark 2.4	Decipher the atomic structure of a material to determine whether it is a conductor, an insulator, or a semiconductor.	PLTW-DE		SC.12.2.1.a SC.12.2.1.f SC.12.2.1.g	

Performance Indicator 2.4.1	Identify the parts of an atom and determine if an element would make a good conductor, insulator, or semiconductor.	PLTW-DE			
Benchmark 2.5	Understand of the basics of electricity requires the understanding of three fundamental concepts of voltage, current, and resistance.	PLTW-DE	MTH.A.CED.1 MTH.A.CED.4	SC.12.2.3.f	
Performance Indicator 2.5.1	Use Ohm's Law, Kirchhoff's Voltage Law, and Kirchhoff's Current Law to solve for simple series and parallel circuit.	PLTW-DE			
Performance Indicator 2.5.2	Be able to use a Circuit Design Software to analyze simple analog circuits.	PLTW-DE			
Benchmark 2.6	Use Circuit Design Software as a tool to verify functionality of their analog and digital designs.	PLTW-DE	ELA.RST.11-12.3	LA.12.1.6.k LA.12.3.2 SC.12.1.3.a	Alignment presumes that students must comprehend oral or written instructions to complete the task (CC: ELA.RST.11-12.3; NE: LA.12.1.6.k, LA.12.3.2).
Performance Indicator 2.6.1	Analyze and design simple digital oscillators using the 555 Timer	PLTW-DE			
Performance Indicator 2.6.2	Determine the amplitude, period, frequency, and duty cycle analog and digital signals.	PLTW-DE			

Standard 3	Students will be introduced to Digital Electronics and demonstrate a basic understanding of those concepts.	PLTW-DE			
Benchmark 3.1	Identify that the manufacturer datasheet contains a logic gate’s general description, connection diagram, and function table.	PLTW-DE	ELA.RST.11-12.5	LA.12.1.6.e-f	
Performance Indicator 3.1.1	Be able to obtain and extract information from the manufacturer datasheets for components commonly used in digital electronics.	PLTW-DE			
Benchmark 3.2	Categorize integrated circuits by their underlying circuitry, scale of integration, and packaging style.	PLTW-DE	ELA.RST.11-12.4	LA.12.1.5	
Performance Indicator 3.2.1	Identify commonly used electronic components given their part number or schematic symbol.	PLTW-DE			
Performance Indicator 3.2.2	Be able to identify various integrated circuit (IC) package styles.	PLTW-DE			
Benchmark 3.3	Transistor-Transistor Logic (TTL) gates are available in a series of sub-families, each having their own advantages and disadvantages related to speed and power.	PLTW-DE			

Performance Indicator 3.3.1	Describe the advantages and disadvantages of TTL gates.	PLTW-DE			
Benchmark 3.4	Logic gates are depicted by their schematic symbol, logic expression, and truth table.	PLTW-DE			
Performance Indicator 3.4.1	Identify and describe the function of AND, OR, & Inverter gates.	PLTW-DE			
Performance Indicator 3.4.2	Be able to use Circuit Design Software (CDS) to simulate and test a simple combinational logic circuit designed with AND, OR, & Inverter gates.	PLTW-DE			
Benchmark 3.5	Understand the input and output values of combinational and sequential logic function differently.	PLTW-DE			
Performance Indicator 3.5.1	Know the fundamental differences between combinational and sequential logic.	PLTW-DE			
Benchmark 3.6	Describe combinational logic designs implemented with AND gates, OR gates, and INVERTER gates are referred to as AOI designs.	PLTW-DE	ELA.WHST.11-12.2.b ELA.SL.11-12.4	LA.12.2.1.b LA.12.3.1.a	When students *describe* information or ideas, they communicate their knowledge through either speaking or writing. To demonstrate full knowledge on the topic, students' presentations must include all the main ideas and relevant details on the subject (CC: ELA.WHST.11-12.2.b, ELA.SL.11-12.4; NE: LA.12.2.1.b, LA.12.3.1.a).

Performance Indicator3.6.1	Be able to use Circuit Design Software (CDS) to simulate and test a simple combinational logic circuit designed with AND, OR, & Inverter gates.	PLTW-DE			
Benchmark 3.7	Understand the flip-flop is the fundamental building block of sequential logic.	PLTW-DE			
Performance Indicator 3.7.1	Be able to use Circuit Design Software (CDS) to simulate and test a simple sequential logic circuit design with D flip-flops.	PLTW-DE			
Performance Indicator 3.7.2	Utilize the Circuit Design Software (CDS) to simulate and test a complete design containing both combinational and sequential logic.	PLTW-DE			
Standard 4	Students will demonstrate an understanding of AOI Logic by basic circuit design.	PLTW-DE			
Benchmark 4.1	An understanding of the binary number system and its relationship to the decimal number system is essential in the combinational logic design process.	PLTW-DE			
Performance Indicator 4.1.1	Convert numbers between the binary and decimal number systems.	PLTW-DE			

Benchmark 4.2	Identify the first step in designing a combinational logic circuit is to translate a set of design specifications into a truth table.	PLTW-DE	ELA.RST.11-12.3	LA.12.1.6.k LA.12.3.2	Alignment presumes that students must comprehend oral or written instructions to complete the task (CC: ELA.RST.11-12.3; NE: LA.12.1.6.k, LA.12.3.2).
Performance Indicator 4.2.1	Translate design specifications into truth tables.	PLTW-DE			
Benchmark 4.3	Illustrate how a truth table describes the behavior of a combinational logic design by listing all possible input combinations and the desired output for each.	PLTW-DE		MA.12.3.1.a	
Performance Indicator 4.3.1	Extract un-simplified logic expressions from truth tables.	PLTW-DE			
Performance Indicator 4.3.2	Construct truth tables from logic expressions.	PLTW-DE			
Benchmark 4.4	Comprehend logic expressions can be derived from a given truth table; likewise, a truth table can be constructed from a given logic expression.	PLTW-DE	MTH.CED.1	MA.12.3.2.a	
Performance Indicator 4.4.1	Use the rules and laws of Boolean algebra, including DeMorgan’s, to simplify logic expressions.	PLTW-DE			

Benchmark 4.5	Understand all logic expressions can be expressed in one of two forms: sum-of-products (SOP) or products of sum (POS).	PLTW-DE	MTH.CED.1	MA.12.3.2.a	
Performance Indicator 4.5.1	Analyze AOI (AND/OR/Invert) combinational logic circuits to determine their equivalent logic expressions and truth tables.	PLTW-DE			
Benchmark 4.6	Recognize all logic expressions, whether simplified or not, can be implemented using AND, OR, & Inverter Gates.	PLTW-DE			
Performance Indicator 4.6.1	Translate a set of design specifications into a functional AOI combinational logic circuit following a formal design process.	PLTW-DE			
Benchmark 4.7	Understand there is a formal design process for translating a set of design specifications into a functional combinational logic circuit.	PLTW-DE		SC.12.1.3.a	
Performance Indicator 4.7.1	Design combinational logic circuits using AOI logic gates.	PLTW-DE			
Standard 5	Students will become familiar with NAND and NOR logic.	PLTW-DE			

Benchmark 5.1	Apply Karnaugh Mapping to simplify logic expressions containing two, three, and four variables.	PLTW-DE	MTH.CED.1	MA.12.3.2.a	
Performance Indicator 5.1.1	Use the K-Mapping technique to simplify combinational logic problems.	PLTW-DE			
Benchmark 5.2	Describe a "don't care condition" as a situation where the design specifications "don't care" what the output is for one or more input conditions. Don't care conditions in Kmaps can lead to significantly simpler logic expressions and circuit implementations.	PLTW-DE	ELA.WHST.11-12.2.b ELA.SL.11-12.4	LA.12.2.1.b LA.12.3.1.a	When students *describe* information or ideas, they communicate their knowledge through either speaking or writing. To demonstrate full knowledge on the topic, students' presentations must include all the main ideas and relevant details on the subject (CC: ELA.WHST.11-12.2.b, ELA.SL.11-12.4; NE: LA.12.2.1.b, LA.12.3.1.a).
Performance Indicator 5.2.1	Be able to solve K-Maps that contain one or more don't care conditions.	PLTW-DE			
Benchmark 5.3	Recognize a NAND gate is considered a universal gate because it can be used to implement an AND gate, OR gate, and an inverter gate. Any combinational logic expression can be implemented using only NAND gates.	PLTW-DE	ELA.RST.11-12.4	LA.12.1.5	
Performance Indicator 5.3.1	Design combinational logic circuit using NAND and NOR logic gates.	PLTW-DE			

Benchmark 5.4	Identify a NOR gate is considered a universal gate because it can be used to implement an AND gate, OR gate, and an inverter gate. Any combinational logic expression can be implemented using only NOR gates.	PLTW-DE	ELA.RST.11-12.4	LA.12.1.5	
Performance Indicator 5.4.1	Design combinational logic circuit using NAND and NOR logic gates.	PLTW-DE			
Performance Indicator 5.4.2	Be able to compare and contrast the quality of combinational logic designs implemented with AOI, NAND, and NOR logic gates.	PLTW-DE			
Benchmark 5.5	Translate a set of design specifications into a functional combinational logic circuit implement with NAND or NOR gates.	PLTW-DE	ELA.RST.11-12.3	LA.12.1.6.k LA.12.3.2	Alignment presumes that students must comprehend oral or written instructions to complete the task (CC: ELA.RST.11-12.3; NE: LA.12.1.6.k, LA.12.3.2).
Performance Indicator 5.5.1	Translate a set of design specifications into a functional NAND or NOR combinational logic circuit following a formal design process.	PLTW-DE			
Performance Indicator 5.5.2	Be able to compare and contrast the quality of combinational logic designs implemented with AOI, NAND, and NOR logic gates.	PLTW-DE			

Benchmark 5.6	Combinational logic designs implemented with NAND gates or NOR gates will typically required fewer Integrated Circuits (IC) than AOI equivalent implementations.	PLTW-DE			
Performance Indicator 5.6.1	Use Circuit Design Software (CDS) and a Digital Logic Board (DLB) to simulate and prototype NAND and NOR logic circuits.	PLTW-DE			
Performance Indicator 5.6.2	Be able to compare and contrast the quality of combinational logic designs implemented with AOI, NAND, and NOR logic gates.	PLTW-DE			
Standard 6	Students will comprehend the date of birth design.	PLTW-DE			
Benchmark 6.1	Seven-segment displays are used to display the digits 0-9 as well as some alpha characters.	PLTW-DE			
Performance Indicator 6.1.1	Use a seven-segment display in a combinational logic design to display alpha/numeric values.	PLTW-DE			

Benchmark 6.2	Describe the two varieties of seven-segment displays are common cathode and common anode.	PLTW-DE	ELA.WHST.11-12.2.b ELA.SL.11-12.4	LA.12.2.1.b LA.12.3.1.a	When students *describe* information or ideas, they communicate their knowledge through either speaking or writing. To demonstrate full knowledge on the topic, students' presentations must include all the main ideas and relevant details on the subject (CC: ELA.WHST.11-12.2.b, ELA.SL.11-12.4; NE: LA.12.2.1.b, LA.12.3.1.a).
Performance Indicator 6.2.1	Select the correct current limiting resistor and properly wire both common cathode and common anode seven-segment displays.	PLTW-DE			
Benchmark 6.3	Any combinational logic expression can be implemented with AOI, NAND, or NOR logic.	PLTW-DE			
Performance Indicator 6.3.1	Design AOI, NAND, & NOR solutions for a logic expression and select the solution that uses the least number of ICs to implement.	PLTW-DE			
Performance Indicator 6.3.2	Use Circuit Design Software (CDS) and Digital Logic Board (DLB) to simulate and prototype AOI, NAND, & NOR logic circuits.	PLTW-DE			
Benchmark 6.4	Utilize a formal design process to translate a set of design specifications into a functional combinational logic circuit.	PLTW-DE	ELA.RST.11-12.3	LA.12.1.6.k LA.12.3.2	Alignment presumes that students must comprehend oral or written instructions to complete the task (CC: ELA.RST.11-12.3; NE: LA.12.1.6.k, LA.12.3.2).

Performance Indicator 6.4.1	Follow a formal design process to translate a set of design specifications for a design containing multiple outputs into a functional combinational logic circuit.	PLTW-DE			
Standard 7	Students will apply specific combination logic circuits to problems.	PLTW-DE			
Benchmark 7.1	Demonstrate an understanding of the hexadecimal and octal number systems and their relationship to the decimal number system as necessary for comprehension of digital electronics.	PLTW-DE			
Performance Indicator 7.1.1	Convert numbers between the hexadecimal or octal number systems and the decimal number system.	PLTW-DE			
Benchmark 7.2	Understand XOR and XNOR gates can be used to implement combinational logic circuits, but their primary intended purpose is for implementing binary adder circuits.	PLTW-DE			
Performance Indicator 7.2.1	Use XOR and XNOR gates to design binary half-adders and full-adders.	PLTW-DE			

Performance Indicator 7.2.2	Use SSI and MSI gates to design and implement binary adders.	PLTW-DE			
Benchmark 7.3	Recognize the addition of two binary numbers of any bit length can be accomplished by cascading one half-adder with one or more full adders.	PLTW-DE			
Performance Indicator 7.3.1	Add two binary numbers.	PLTW-DE			
Benchmark 7.4	Understand multiplexer/de-multiplexer pairs are most frequently used when a single connection must be shared between multiple inputs and multiple outputs.	PLTW-DE			
Performance Indicator 7.4.1	Use Circuit Design Software (CDS) and a Digital Logic Board (DLB) to simulate and prototype specific combinational logic circuits.	PLTW-DE			
Benchmark 7.5	Electronics displays that use multiple seven-segment display utilize demultiplexers to significantly reduce the amount of power required to operate the display.	PLTW-DE			
Performance Indicator 7.5.1	Design electronics displays using seven-segment displays that utilize demultiplexers.	PLTW-DE			

Benchmark 7.6	Comprehend two’s complement arithmetic is the most commonly used method for handling negative numbers in digital electronics.	PLTW-DE			
Performance Indicator 7.6.1	Use the two’s complement process to add and subtract binary numbers.	PLTW-DE			
Standard 8	Students will use combinational programmable logic.	PLTW-DE			
Benchmark 8.1	Use Circuit Design Software to enter and synthesize digital designs into programmable logic devices.	PLTW-DE	ELA.RST.11-12.3	LA.12.1.6.k LA.12.3.2	Alignment presumes that students must comprehend oral or written instructions to complete the task (CC: ELA.RST.11-12.3; NE: LA.12.1.6.k, LA.12.3.2).
Performance Indicator 8.1.1	Design combinational logic circuits using a programmable logic device.	PLTW-DE			
Performance Indicator 8.1.2	Use Circuit Design Software (CDS) and a Digital Logic Board (DLB) to simulate and prototype combinational logic designs implemented with programmable logic.	PLTW-DE			
Benchmark 8.2	Use programmable logic devices to implement combinational logic circuits.	PLTW-DE	ELA.RST.11-12.3	LA.12.1.6.k LA.12.3.2	Alignment presumes that students must comprehend oral or written instructions to complete the task (CC: ELA.RST.11-12.3; NE: LA.12.1.6.k, LA.12.3.2)
Performance Indicator 8.2.1	Design combinational logic circuits using a programmable logic device.	PLTW-DE			

Benchmark 8.3	Describe the strengths and limitations of circuits implemented with programmable logic devices.	PLTW-DE	ELA.WHST.11-12.2.b ELA.SL.11-12.4	LA.12.2.1.b LA.12.3.1.a	When students *describe* information or ideas, they communicate their knowledge through either speaking or writing. To demonstrate full knowledge on the topic, students' presentations must include all the main ideas and relevant details on the subject (CC: ELA.WHST.11-12.2.b, ELA.SL.11-12.4; NE: LA.12.2.1.b, LA.12.3.1.a).
Performance Indicator 8.3.1	Be able to cite the advantages and disadvantages of programmable logic devices over discrete logic gates.	PLTW-DE			
Standard 9	Students will apply sequential logic.	PLTW-DE			
Benchmark 9.1	Understand that the flip-flop and transparent latch are logic devices that have the capability to store data and can act as a memory device.	PLTW-DE	ELA.RST.11-12.4	LA.12.1.5	
Performance Indicator 9.1.1	Know the schematic symbols and excitation tables for the D and J/K flip-flops.	PLTW-DE			
Performance Indicator 9.1.2	Describe the function of the D and J/K flip-flops.	PLTW-DE			
Benchmark 9.2	Describe how Flip-flops and transparent latches have both synchronous and asynchronous inputs.	PLTW-DE	ELA.WHST.11-12.2.b ELA.SL.11-12.4	LA.12.2.1.b LA.12.3.1.a	When students *describe* information or ideas, they communicate their knowledge through either speaking or writing. To demonstrate full knowledge on the topic, students' presentations must include all the main ideas and relevant details on the subject (CC: ELA.WHST.11-12.2.b, ELA.SL.11-12.4; NE: LA.12.2.1.b, LA.12.3.1.a).

Performance Indicator 9.2.1	Describe the function of, and differences between, level sensitive and edge sensitive triggers.	PLTW-DE			
Performance Indicator 9.2.2	Describe the function of, and differences between, a flip-flop's synchronous and asynchronous inputs.	PLTW-DE			
Benchmark 9.3	Comprehend how flip-flops can be used to design single event detection circuits, data synchronizers, shift registers, and frequency dividers.	PLTW-DE			
Performance Indicator 9.3.1	Describe the function of, and differences between, active high and active low signals.	PLTW-DE			
Performance Indicator 9.3.2	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.	PLTW-DE			
Performance Indicator 9.3.3	Analyze and design introductory flip-flop applications such as event detection circuits, data synchronizers, shift registers, and frequency dividers.	PLTW-DE			
Performance Indicator 9.3.4	Use Circuit Design Software (CDS) and a Digital Logic Board (DLB) to simulate and prototype introductory flip-flop applications.	PLTW-DE			
Standard 10	Students will utilize asynchronous counters.	PLTW-DE			

Benchmark 10.1	Recognize 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.	PLTW-DE	ELA.RST.11-12.4	LA.12.1.5	
Performance Indicator 10.1.1	Know the advantages and disadvantage of counters designed using the asynchronous counter method.	PLTW-DE			
Performance Indicator 10.1.2	Be able to describe the ripple effect of an asynchronous counter.	PLTW-DE			
Benchmark 10.2	Asynchronous counters can be implemented using small scale integrated (SSI) and medium scale integrated (MSI) logic gates and either D or J/K flip-flops.	PLTW-DE			
Performance Indicator 10.2.1	Be able to analyze and design up, down and modulus asynchronous counters using medium scale integrated (MSI) circuit counters.	PLTW-DE			
Performance Indicator 10.2.2	Use Circuit Design Software (CDS) and Digital Logic Board (DLB) to simulate and prototype SSI and MSI asynchronous counters.	PLTW-DE			

Benchmark 10.3	Understand up counters, down counters, and modulus counters all can be implemented using the asynchronous counter method.	PLTW-DE			
Performance Indicator 10.3.1	Be able to analyze and design up, down and modulus asynchronous counters using discrete D and J/K flip-flops.	PLTW-DE			
Performance Indicator 10.3.2	Be able to analyze and design up, down and modulus asynchronous counters using medium scale integrated (MSI) circuit counters.	PLTW-DE			
Standard 11	Students will utilize synchronous counters.	PLTW-DE			
Benchmark 11.1	Describe synchronous counters, also called parallel counters, are characterized by an external signal clocking all flip-flops simultaneously.	PLTW-DE	ELA.WHST.11-12.2.b ELA.SL.11-12.4	LA.12.2.1.b LA.12.3.1.a	When students *describe* information or ideas, they communicate their knowledge through either speaking or writing. To demonstrate full knowledge on the topic, students' presentations must include all the main ideas and relevant details on the subject (CC: ELA.WHST.11-12.2.b, ELA.SL.11-12.4; NE: LA.12.2.1.b, LA.12.3.1.a).
Performance Indicator 11.1.1	Be able to analyze and design up, down and modulus synchronous counters using discrete D and J/K flip-flops.	PLTW-DE			

Benchmark 11.2	Synchronous counters can be implemented using small scale integrated (SSI) and medium scale integrated (MSI) logic gates.	PLTW-DE			
Performance Indicator 11.2.1	Be able to analyze and design up, down and modulus synchronous counters using medium scale integrated (MSI) circuit counters.	PLTW-DE			
Benchmark 11.3	Recognize synchronous counters can be implemented with either D or J/K flip-flops.	PLTW-DE			
Performance Indicator 11.3.1	Be able to analyze and design up, down and modulus synchronous counters using discrete D and J/K flip-flops.	PLTW-DE			
Benchmark 11.4	Understand how up counters, down counters, and modulus counters all can be implemented using the synchronous counter method.	PLTW-DE			
Performance Indicator 11.4.1	Know the advantages and disadvantage of counters designed using the synchronous counter method.	PLTW-DE			
Performance Indicator 11.4.2	Use Circuit Design Software (CDS) and Digital Logic Board (DLB) to simulate and prototype SSI and MSI synchronous counters.	PLTW-DE			

Standard 12	Students will describe state-machine design.	PLTW-DE			
Benchmark 12.1	Describe how a state machine is a circuit design that sequences through a set of predetermined states controlled by a clock and other input signals.	PLTW-DE	ELA.WHST.11-12.2.b ELA.SL.11-12.4	LA.12.2.1.b LA.12.3.1.a	When students *describe* information or ideas, they communicate their knowledge through either speaking or writing. To demonstrate full knowledge on the topic, students' presentations must include all the main ideas and relevant details on the subject (CC: ELA.WHST.11-12.2.b, ELA.SL.11-12.4; NE: LA.12.2.1.b, LA.12.3.1.a).
Performance Indicator 12.1.1	Be able to describe the components of a state machine.	PLTW-DE			
Benchmark 12.2	Identify state machines are used to control common everyday devices such as elevator doors, traffic lights, and combinational (electronics) locks.	PLTW-DE			
Performance Indicator 12.2.1	Be able to draw a state graph and construct a state transition table for a state machine.	PLTW-DE			
Benchmark 12.3	Understand state machines can be implemented in one of two variations: Mealy or Moore.	PLTW-DE			
Performance Indicator 12.3.1	Describe the two variations of state machines and list the advantages of each.	PLTW-DE			

Benchark 12.4	Comprehend state machines can be implemented using small and medium scale integrated gates and programmable logic devices.	PLTW-DE			
Performance Indicator 12.4.1	Use Circuit Design Software (CDS) and a Digital Logic Board (DLB) to simulate and prototype state machines designs implemented with discrete and programmable logic.	PLTW-DE			
Performance Indicator 12.4.2	Be able to derive a state machine's Boolean equations from its state transition table.	PLTW-DE			
Performance Indicator 12.4.3	Be able to implement Boolean equations into a functional state machine.	PLTW-DE			
Standard 13	Students will understand the basic components and functions of microcontrollers.	PLTW-DE			
Benchmark 13.1	Recognize flowcharting is a powerful graphical organizer used by technicians, computer programmers, engineers, and professionals in a variety of roles and responsibilities.	PLTW-DE			
Performance Indicator 13.1.1	Create flowcharts to use in programming	PLTW-DE			

Benchmark 13.2	Understand basic programming skills including variable declaration, loops, and debugging as well as programming language.	PLTW-DE			
Performance Indicator 13.2.1	Create programs that use various loops	PLTW-DE			
Performance Indicator 13.2.2	Create a program that utilizes the Debug screen	PLTW-DE			
Performance Indicator 13.2.3	Create programs that use variables	PLTW-DE			
Performance Indicator 13.2.4	Use the Board of Education to write programs	PLTW-DE			
Performance Indicator 13.2.5	Create programs that use inputs and outputs	PLTW-DE			
Performance Indicator 13.2.6	Identify variables used in programming are declared and given a size that is expressed in binary.	PLTW-DE			
Standard 14	Students will understand the basic hardware of microcontrollers.	PLTW-DE			
Benchmark 14.1	Identify microcontrollers are used to control many everyday products like robots, garage door openers, traffic lights, and home thermostats.	PLTW-DE			
Performance Indicator 14.1.1	Use mathematics to calculate programming values.	PLTW-DE			
Benchmark 14.2	Understand a servo motor is one that delivers continuous motion at various speeds.	PLTW-DE	ELA.RST.11-12.4	LA.12.1.5	

Performance Indicator 14.2.1	Program a servo motor.	PLTW-DE			
Benchmark 14.3	Describe microcontrollers can be programmed to sense and respond to outside stimuli	PLTW-DE	ELA.WHST.11-12.2.b ELA.SL.11-12.4	LA.12.2.1.b LA.12.3.1.a	When students *describe* information or ideas, they communicate their knowledge through either speaking or writing. To demonstrate full knowledge on the topic, students' presentations must include all the main ideas and relevant details on the subject (CC: ELA.WHST.11-12.2.b, ELA.SL.11-12.4; NE: LA.12.2.1.b, LA.12.3.1.a).
Performance Indicator 14.3.1	Program and test an autonomous robot.	PLTW-DE			
Standard 15	Students will be able to understand the purpose and use of process controll miccontrollers	PLTW-DE			
Benchmark 15.1	Digital devices are only relevant if they can interact with the real world.	PLTW-DE		SC.12.1.3.a SC.12.1.3.b SC.12.1.3.c SC.12.1.3.d	Alignment presumes that students will design a maze course and implement their digital design device (NE: SC.12.1.3.a, SC.12.1.3.c).
Performance Indicator 15.1.1	Design and build a maze course.	PLTW-DE			
Performance Indicator 15.1.2	Design and build a timing device with remote triggers.	PLTW-DE			
Performance Indicator 15.1.3	Program a microcontroller to guide a robot through a maze.	PLTW-DE			
Benchmark 15.2	Digital control devices are increasingly necessary for mechanical systems.	PLTW-DE		SC.12.1.3.a SC.12.1.3.b SC.12.1.3.c SC.12.1.3.d	Alignment presumes that students will design a timing device and implement their control device used for mechanical systems (NE: SC.12.1.3.a, SC.12.1.3.c).

Performance Indicator 15.2.1	Design and build a timing device with remote triggers.	PLTW-DE			
Performance Indicator 15.2.2	Program a microcontroller to guide a robot through a maze.	PLTW-DE			
Benchmark 15.3	Realistic problem solving with a control system requires the ability to interface analog inputs and outputs with a digital device.	PLTW-DE		SC.12.1.3.a SC.12.1.3.b SC.12.1.3.c SC.12.1.3.d	Alignment presumes that students will design a timing device and implement their control device used to interface analog inputs and outputs (NE: SC.12.1.3.a, SC.12.1.3.c).
Performance Indicator 15.3.1	Design and build a timing device with remote triggers.	PLTW-DE			
Performance Indicator 15.3.2	Program a microcontroller to guide a robot through a maze.	PLTW-DE			
Benchmark 15.4	Microcontrollers are a practical tool for controlling a mechanical system.	PLTW-DE		SC.12.1.3.a SC.12.1.3.b SC.12.1.3.c SC.12.1.3.d	Alignment presumes that students will design a timing device and implement their control device used for mechanical systems(NE: SC.12.1.3.a, SC.12.1.3.c).
Performance Indicator 15.4.1	Design and build a timing device with remote triggers.	PLTW-DE			
Performance Indicator 15.4.2	Program a microcontroller to guide a robot through a maze.	PLTW-DE			