STRANDS AND STANDARDS
PLTW DIGITAL ELECTRONICS

Course Description
Digital Electronics is an introduction to applied digital logic, a key element of careers in engineering and engineering technology. This course explores the smart circuits found in watches, calculators, video games, and computers. Students use industry-standards computer software in testing and analyzing digital circuitry. They design circuits to solve problems, export their designs to a printed circuit auto-routing program that generates printed circuit boards, and use appropriate components to build their designs. Students use mathematics and science in solving real-world engineering problems.

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<td>Units of Credit</td>
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<td>Intended Grade Level</td>
<td>10-12</td>
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<tr>
<td>Prerequisite</td>
<td>PLTW IDE, PLTW PoE</td>
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<td>License Type</td>
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<td>Limited Engineering, or</td>
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STRAND 1
Students will learn about the fundamentals of digital electronics.

Standard 1
Identify hazards in the lab and know locations of the safety equipment and how to use it.
• Understand the causes of and the dangers from electric shock and explain methods
to prevent it.
• Understand that the process of designing an electronic circuit takes into account
many factors, including environment concerns, and will be familiar with
precautionary measures.

Standard 2
Label the parts of the atom.
• Explain the relationship of quantum energy required to strip away electrons
from atoms to being classified as an insulator or conductor.

Standard 3
Define and explain the difference between direct and alternating currents.

Standard 4
Re-write any number using conventional prefix definitions.

Standard 5
Understand the material makeup of resistors and how they are used in circuit design.
• Understand the symbols associated with resistors.
• Correctly setup lab equipment to measure resistor values in order to compare
measured and rated values.
• Calculate the tolerance levels of various resistors to determine if the measured value
is within specifications.

Standard 6
Build and test a variety of series and parallel circuits, using simulation software and proto-
boards, to prove the accuracy of Ohm’s and Kirchhoff’s laws.
• Draw and label the parts of a simple circuit.
• Correctly select and utilize electrical meters to determine voltage, resistance and
current in simple circuits.
• Learn how to apply Kirchhoff’s voltage and current laws to closed loops.
• Calculate the resistance, current and voltage in a circuit using Ohm’s Law.

Standard 7
Describe the component parts of a capacitor and describe how a capacitor holds a static charge.
• Use and understand the units of measurement for capacitors.
• Calculate the value of capacitors mathematically and through the use of
instrumentation.
• Be familiar with different types of capacitors and their voltage polarity requirements.

Standard 8
Draw a digital waveform and identify the anatomy of the waveform.
• Differentiate between digital and analog signals when given the waveforms.

Standard 9
Wire and test a free-running clock circuits using a 555 timer.
• Calculate the output frequency of a clock circuits using observations and the oscilloscope.

STRAND 2
Students will learn about number systems.

Standard 1
Understand numerical place value.

Standard 2
Use mathematical symbols to represent different bases and will communicate concepts using different number systems.

Standard 3
Demonstrate the relationship of binary and hexadecimal to bits and bytes of information used in computers.

Standard 4
Convert values from one number system to another.

STRAND 3
Students will learn about logic gates.

Standard 1
Use schematics and symbolic Algebra to represent digital gates in the creation of solutions to design problems.

Standard 2
Identify the name, symbol, and function and create the truth table, and Boolean Expression for the basic logic gates through research and experimentation.

Standard 3
Apply logic to design and create simple circuits, using gates in the creation of solutions to a problem.
STRAND 4
Students will learn about Boolean Algebra.

Standard 1
Recognize the relationship between the Boolean expression, logic diagram, and truth table.

Standard 2
Create Boolean Expressions, logic circuit diagrams or truth tables from information provided in the solution of design problems.

Standard 3
Appropriately select the Sum-of-Products or the Product-of-Sums form of a Boolean Expression to use in the solution of a problem.

Standard 4
Apply the rules of Boolean algebra to logic diagrams and truth tables to minimize the circuit size necessary to solve a design problem.

Standard 5
Use DeMorgan’s Theorem to simplify a negated expression and to convert a SOP to a POS and visa versa in order to save resources in the production of circuits.

Standard 6
Formulate and employ a Karnaugh Map to reduce Boolean expressions and logic circuits to their simplest forms.

Standard 7
Create circuits to solve a problem using NAND or NOR gates to replicate all logic functions.

Standard 8
Apply their understanding of the workings of NOR and NAND gates to make comparisons with standard combinational logic solutions to determine amount of resource reduction.

STRAND 5
Students will learn about circuit design.

Standard 1
Restate and simplify a digital design problem as part of the systematic approach to solving a problem.

Standard 2
Design, construct, build, troubleshoot, and evaluate a solution to a design problem.

Standard 3
Present an oral report presenting a solution and evaluation of a design problem of their choice.
Standard 4
Discover the code to create numbers on a seven segment display by experimentation.

Standard 5
Design a circuit to control a seven segment display with a decimal to BCD encoder and a display driver.

Standard 6
Control the flow of data by utilizing Multiplexers and De-multiplexers.

Standard 7
Design and implement combinational logic circuits using reprogrammable logic devices.

Standard 8
Create PLD logic files that define combinational circuit designs using Boolean Expressions.

Standard 9
Understand and use logic compiler software to create JEDEC files for programming PLDs.

STRAND 6
Students will learn about binary addition.

Standard 1
Demonstrate understanding of binary addition and subtraction by designing circuits to produce correct answers.

Standard 2
Create and prove the truth table for both half and full adders.

Standard 3
Design, construct and test adder circuits using both discrete gates and MSI gates.

STRAND 7
Students will learn about Flip-Flops.

Standard 1
Construct and test simple latches and flip-flops from discrete gates.

Standard 2
Interpret, design, draw, and evaluate circuits using the logic symbols for latches and flip-flops.

Standard 3
Interpret waveform diagrams from circuits they construct and compare them with combinational waveforms.
Standard 4
Compare and contrast operation of synchronous with asynchronous flip-flop circuits they construct.

Standard 5
Create and interpret timing diagrams and truth tables for J-K Flip-Flops.

Standard 6
Understand the different types of triggers used by latches and flip-flops and select the appropriate one for the circuits they design.

Standard 7
Analyze timing diagrams that reflect triggering to identify distinguishing characteristics.

Standard 8
Conduct experiments with clock pulse width to determine the effect on the accuracy of data transmission.

Standard 9
Assemble circuits and compile information about the various applications of flip-flops.

STRAND 8
Students will learn about shift registers & counters.

Standard 1
Conduct experiments to determine the basic principles of how shift registers work.

Standard 2
Evaluate the use of shift registers in product design and the speeds at which those products run.

Standard 3
Create a circuit using discrete flip-flops to discover the operation and characteristics of asynchronous counters.

Standard 4
Design, simulate, build and test Mod counters using discrete gates in the solution to a design problem.

Standard 5
Design, simulate, build and test asynchronous Mod counters using an integrated counter chip (MSI).

Standard 6
Design, simulate, build and test synchronous Mod counters using discrete gates to solve a problem.
Standard 7
Students will design, simulate, build and test synchronous Mod counters using an integrated counter chip in the solution to a design problem.

STRAND 9
Students will learn about families & specifications.

Standard 1
Interpret the graphs, charts and written materials contained in a data sheet and apply it to a design problem.

Standard 2
Correctly setup and use an oscilloscope to observe and measure propagation delay in a digital circuit.

Standard 3
Define, calculate, and measure noise margin, drive capabilities, fan-out and propagation delay.

Standard 4
List safety precautions for handling CMOS chips.

STRAND 10
Students will learn about microprocessors.

Standard 1
Formulate a flow chart to correctly apply basic programming concepts in the planning of a project.

Standard 2
Design and create a program, using correct syntax, to evaluate data and make decisions based on information gathered from the environment using external digital and analog sensors.

Standard 3
Create an interface to allow them to inspect, evaluate and manage program parameters in the microprocessor during the operation of a program.

Standard 4
Design and create a program in correct syntax allowing a microprocessor to evaluate external data in order to operate motors and other devices to control the external environment.

Standard 5
 Appropriately select, size, and implement interface devices to control external devices.

Standard 6
Design and create programming to control the position of stepper motors.