# DIGITAL ELECTRONICS
Course Syllabus

<table>
<thead>
<tr>
<th>Course Number:</th>
<th>ST00021</th>
<th>OHLAP Credit:</th>
<th>No</th>
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<tbody>
<tr>
<td>OCAS Code:</td>
<td>8711</td>
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<tr>
<td>Course Length:</td>
<td>120 Hours</td>
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<tr>
<td>Career Cluster:</td>
<td>Science, Technology, Engineering and Mathematics</td>
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<td>Career Pathway:</td>
<td>Engineering and Technology</td>
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<td>Career Major(s):</td>
<td>PLTW Pre-Engineering (Comprehensive High Schools), PLTW Pre-Engineering</td>
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**Pre-requisite(s):**

Digital Electronics is a course in applied logic that encompasses the application of electronic circuits and devices. Computer simulation software is used to design and test digital circuitry prior to the actual construction of circuits and devices.

**Textbooks:**

Project Lead the Way Materials

**Course Objectives:**

**Unit 1: Fundamentals of Analog and Digital Electronics**

- Know and practice proper safety while working with electronics.
- Be able to express numbers in scientific notation, engineering notation, and System International (SI) notation.
- Identify many of the common components used in electronics.
- Be able to determine a resistor’s nominal value by reading its color code.
- Be able to determine a resistor’s actual value by reading its resistance with a Digital Multimeter (DMM).
- Be able to determine a capacitor’s nominal value by reading its labeled nomenclature.
- Be able to properly tin the tip of a soldering iron.
- Use proper soldering/de-soldering techniques to solder and de-solder components on a printed circuit boards.

**Performance Objectives Addressed in Lesson**

It is expected that students will:

- Be able to identify the parts of an atom and determine if an element would make a good conductor, insulator, or semiconductor.

**Lesson 1.2: Introduction to Analog**

**Performance Objectives Addressed in Lesson**

It is expected that students will:
Use Ohm’s Law, Kirchhoff’s Voltage Law, and Kirchhoff’s Current Law to solve for simple series and parallel circuit.

Be able to use a Circuit Design Software to analyze simple analog circuits.

Be able to use a breadboard and digital multimeter to analyze simple analog circuits.

Be able to determine the amplitude, period, frequency, and duty cycle analog and digital signals.

Be able to analyze and design simple digital oscillators using the 555 Timer chip.

Utilize the Circuit Design Software (CDS) to simulate and test a complete analog design.

Lesson 1.3: Introduction to Digital

Performance Objectives Addressed in Lesson
It is expected that students will:

- Be able to obtain and extract information from the manufacturer datasheets for components commonly used in digital electronics.
- Know how to identify commonly used electronic components given their part number or schematic symbol.
- Be able to identify various integrated circuit (IC) package styles.
- Know the fundamental differences between combinational and sequential logic.
- Identify and describe the function of AND, OR, & Inverter gates.
- Be able to use Circuit Design Software (CDS) to simulate and test a simple combinational logic circuit designed with AND, OR, & Inverter gates.
- Identify and describe the function of a D flip-flop.
- Be able to use Circuit Design Software (CDS) to simulate and test a simple sequential logic circuit design with D flip-flops.
- Utilize the Circuit Design Software (CDS) to simulate and test a complete design containing both combinational and sequential logic.

Unit 2: Combinational Logic

Lesson 2.1: Introduction to AOI Logic

Performance Objectives Addressed in Lesson
It is expected that students will:

- Convert numbers between the binary and decimal number systems.
- Translate design specifications into truth tables.
- Extract un-simplified logic expressions from truth tables.
- Construct truth tables from logic expressions.
- Use the rules and laws of Boolean algebra, including DeMorgan’s, to simplify logic expressions.
- Analyze AOI (AND/OR/Invert) combinational logic circuits to determine their equivalent logic expressions and truth tables.
- Design combinational logic circuits using AOI logic gates.
- Translate a set of design specifications into a functional AOI combinational logic
circuit following a formal design process.

• Use Circuit Design Software (CDS) and a Digital Logic Board (DLB) to simulate and prototype AOI logic circuits.

Lesson 2.2: Introduction to NAND and NOR Logic

Performance Objectives Addressed in Lesson

It is expected that students will:

• Use the K-Mapping technique to simplify combinational logic problems containing two, three, and four variables.
• Be able to solve K-Maps that contain one or more don’t care conditions.
• Design combinational logic circuit using NAND and NOR logic gates.
• Translate a set of design specifications into a functional NAND or NOR combinational logic circuit following a formal design process.
• Be able to compare and contrast the quality of combinational logic designs implemented with AOI, NAND, and NOR logic gates.
• Use Circuit Design Software (CDS) and a Digital Logic Board (DLB) to simulate and prototype NAND and NOR logic circuits.

Lesson 2.3: Date of Birth Design

Performance Objectives Addressed in Lesson

It is expected that students will:

• Use a seven-segment display in a combinational logic design to display alpha/numeric values.
• Select the correct current limiting resistor and properly wire both common cathode and common anode seven-segment displays.
• Follow a formal design process to translate a set of design specifications for a design containing multiple outputs into a functional combinational logic circuit.
• Design AOI, NAND, & NOR solutions for a logic expression and select the solution that uses the least number of ICs to implement.
• Use Circuit Design Software (CDS) and Digital Logic Board (DLB) to simulate and prototype AOI, NAND, & NOR logic circuits.

Lesson 2.4: Specific Comb Logic Circuits & Misc. Topics

Performance Objectives Addressed in Lesson

It is expected that students will:

• Convert numbers between the hexadecimal or octal number systems and the decimal number system.
• Use XOR and XNOR gates to design binary half-adders and full-adders.
• Use SSI and MSI gates to design and implement binary adders.
• Design electronics displays using seven-segment displays that utilize de-
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- Use the two’s complement process to add and subtract binary numbers.
- Use Circuit Design Software (CDS) and a Digital Logic Board (DLB) to simulate and prototype specific combinational logic circuits.

Lesson 2.5: Programmable Logic – Combinational

Performance Objectives Addressed in Lesson

It is expected that students will:

- Design combinational logic circuits using a programmable logic device.
- Be able to cite the advantages and disadvantages of programmable logic devices over discrete logic gates.
- Use Circuit Design Software (CDS) and a Digital Logic Board (DLB) to simulate and prototype combinational logic designs implemented with programmable logic.

Unit 3: Sequential Logic

Lesson 3.1: Latches & Flip-Flops

Performance Objectives Addressed in Lesson

It is expected that students will:

- Know the schematic symbols and excitation tables for the D and J/K flip-flops.
- Describe the function of the D and J/K flip-flops.
- Describe the function of, and differences between, level sensitive and edge sensitive triggers.
- Describe the function of, and differences between, active high and active low signals.
- Describe the function of, and differences between, a flip-flop’s synchronous and asynchronous inputs.
- 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.
- Analyze and design introductory flip-flop applications such as event detection circuits, data synchronizers, shift registers, and frequency dividers.
- Use Circuit Design Software (CDS) and a Digital Logic Board (DLB) to simulate and prototype introductory flip-flop applications.

Lesson 3.2: Asynchronous Counter

Performance Objectives Addressed in Lesson

It is expected that students will:

- Know the advantages and disadvantage of counters designed using the asynchronous counter method.
- Be able to describe the ripple effect of an asynchronous counter.
- Be able to analyze and design up, down and modulus asynchronous counters using discrete D and J/K flip-flops.
- Be able to analyze and design up, down and modulus asynchronous counters using medium scale integrated (MSI) circuit counters.
- Use Circuit Design Software (CDS) and Digital Logic Board (DLB) to simulate and prototype SSI and MSI asynchronous counters.
Lesson 3.3: Synchronous Counters

Performance Objectives Addressed in Lesson
It is expected that students will:

- Know the advantages and disadvantage of counters designed using the synchronous counter method.
- Be able to analyze and design up, down and modulus synchronous counters using discrete D and J/K flip-flops.
- Be able to analyze and design up, down and modulus synchronous counters using medium scale integrated (MSI) circuit counters.
- Use Circuit Design Software (CDS) and Digital Logic Board (DLB) to simulate and prototype SSI and MSI synchronous counters.

Lesson 3.4: Introduction to State-Machine Design

Performance Objectives Addressed in Lesson
It is expected that students will:

- Be able to describe the components of a state machine.
- Be able to draw a state graph and construct a state transition table for a state machine.
- Be able to derive a state machine’s Boolean equations from its state transition table.
- Be able to implement Boolean equations into a functional state machine.
- Describe the two variations of state machines and list the advantages of each.
- Use Circuit Design Software (CDS) and a Digital Logic Board (DLB) to simulate and prototype state machines designs implemented with discrete and programmable logic.

Unit 4: Microcontrollers

Lesson 4.1: Introduction to Microcontrollers

Performance Objectives Addressed in Lesson
It is expected that students will:

- Create flowcharts to use in programming
- Use the Board of Education to write programs
- Create a program that utilizes the Debug screen
- Create programs that use variables
- Create programs that use various loops
- Create programs that use inputs and outputs

Lesson 4.2: Microcontroller: Hardware

Performance Objectives Addressed in Lesson
It is expected that students will:

- Program a servo motor.
- Program and test an autonomous robot.
- Use mathematics to calculate programming values.

Lesson 4.3: Microcontroller: Process Control

Performance Objectives

It is expected that students will:

- Design and build a maze course.
- Design and build a timing device with remote triggers.
- Program a microcontroller to guide a robot through a maze.

All PLTW objectives

Teaching Methods: The class will primarily be taught by the lecture and demonstration method and supported by various media materials to address various learning styles. There will be question and answer sessions over material covered in lecture and media presentations. Supervised lab time is provided for students to complete required projects.

Grading Procedures: 1. Students are graded on theory and shop practice and performance.
2. Each course must be passed with seventy (70%) percent or better.
3. Grading scale: A=90-100%, B=80-89%, C=70-79%, D=60-69%, F=50-59%.

Description of Classroom, Laboratories, and Equipment: Tulsa Technology Center campuses are owned and operated by Tulsa Technology Center School District No. 18. All programs provide students the opportunity to work with professionally certified instructors in modern, well-equipped facilities.

Available Certifications/College Credit: The student may be eligible to take state, national or industry exam after completion of the program. College credit may be issued from Oklahoma State University-Okmulgee or Tulsa Community College. See program counselor for additional information.

College Credit Eligibility: The student must maintain a grade point average of 2.0 or better.