career **tech**

Project Lead the Way
Pre-Engineering
Course Sequence

Block Scheduling: 2-85 minute classes per semester
4 classes/year or A/B Block

Project Lead the Way (PLTW) Pre-Engineering—2 year Program

Course (OCAS Code)	Minimum Course Hours
First Year	
PLTW-Introduction To Engineering Design (8709)	120
Choose one of the following Advanced Mathematics courses: Geometry (4520), Algebra II (4412), Trigonometry/Pre-Calculus (4750/4611), Pre-AP Calculus (4612)	120
Choose one of the following Advanced Laboratory Science courses: Pre-AP Chemistry (5051), Pre-AP Physics (5211), AP Chemistry (5055), AP Physics B (5215), AP Physics 1 (5213), AP Physics 2 (5214), AP Physics C-Mechanics (5216), AP Physics C-Elec. & Magnetism (5217) AP Biology (5035), AP Environmental Science (5121)	120
PLTW-Principles of Engineering (8710)	120
Second Year	
Choose one of the following PLTW-Engineering Specialty Courses: Digital Electronics (8711), Computer-Integrated Manufacturing(8712), Civil Engineering and Architecture (8713), Biological Engineering/Environmental Sustainability (8854), Aerospace Engineering (8715) Computer Science and Software	120

AP Physics B (5215), AP Physics 1 (5213), AP Physics 2 (5214), AP Physics C-Mechanics (5216), AP Physics C-Elec. & Magnetism (5217) AP Biology (5035), AP Environmental Science (5121), Anatomy/Physiology (5333/5220), Microbiology (5336)	
PLTW Biomedical Innovations (8719)	120
Total—12 Courses	Total Program Hours-1440

Engineering	
Choose one of the following Advanced Mathematics courses: Trigonometry/Pre-Calculus (4750/4611), Pre-AP Calculus (4612), AP Calculus AB (4615), AP Calculus BC (4616), AP Statistics (4760)	120
Choose one of the following Advanced Laboratory Science courses: Pre-AP Chemistry (5051), Pre-AP Physics (5211), AP Chemistry (5055), AP Physics B (5215), AP Physics 1 (5213), AP Physics 2 (5214), AP Physics C-Mechanics (5216), AP Physics C-Elec. & Magnetism (5217), AP Biology (5035), AP Environmental (5121)	120
PLTW-Engineering Design and Development-Capstone (8716)	120
Total—8 Courses	**Total Program hours-960**

PLTW Advanced Pre-Engineering—3-year program

Course (OCAS Code)	Minimum Course Hours
First Year	
PLTW-Introduction To Engineering Design (8709)	120
Choose one of the following Advanced Mathematics: Geometry (4520), Algebra II (4412), Trigonometry/Pre-Calculus (4750/4611), Pre-AP Calculus (4612)	120
Choose one of the following Advanced Laboratory Sciences: Pre-AP Chemistry (5051), Pre-AP Physics (5211), AP Chemistry (5055), AP Physics B (5215), AP Physics 1 (5213), AP Physics 2 (5214), AP Physics C-Mechanics (5216), AP Physics C-Elec. & Magnetism (5217) AP Biology (5035), AP Environmental Science (5121)	120
PLTW-Principles of Engineering (8710)	120
Second Year	
Choose one of the following PLTW-Engineering Specialty Courses: Digital Electronics (8711), Computer Integrated Manufacturing (8712), Civil Engineering and Architecture (8713), Biological Engineering/Environmental Sustainability (8854), Aerospace Engineering (8715) Computer Science and Software Engineering (8851)	120
Choose one of the following Advanced Mathematics: Trigonometry/Pre-Calculus (4750/4611), Pre-AP Calculus (4612),	120

AP Calculus AB (4615), AP Calculus BC (4616), AP Statistics (4760)	
Choose one of the following **Advanced Laboratory Sciences:** Pre-AP Chemistry (5051), Pre-AP Physics (5211), AP Chemistry (5055), AP Physics B (5215), AP Physics 1 (5213), AP Physics 2 (5214), AP Physics C-Mechanics (5216), AP Physics C-Elec. & Magnetism (5217), AP Biology (5035), AP Environmental Science (5121)	120
Choose one of the following **PLTW-Engineering Specialty Courses:** Digital Electronics (8711), Computer Integrated Manufacturing (8712), Civil Engineering and Architecture (8713), Biological Engineering/Environmental Sustainability (8854), Aerospace Engineering (8715) Computer Science and Software Engineering (8851)	120
Third Year	
Choose one of the following **PLTW-Engineering Specialty Courses:** Digital Electronics (8711), Computer Integrated Manufacturing 8712), Civil Engineering and Architecture (8713), Biological Engineering/Environmental Sustainability (8854), Aerospace Engineering (8715) Computer Science and Software Engineering (8851)	120
Choose one of the following **Advanced Mathematics:** Trigonometry/Pre-Calculus (4750/4611), Pre-AP Calculus (4612), AP Calculus AB (4615), AP Calculus BC (4616), AP Statistics (4760)	120
Choose one of the following **Advanced Laboratory Sciences:** Pre-AP Chemistry (5051), Pre-AP Physics (5211), AP Chemistry (5055), AP Physics B (5215),	120

AP Physics 1 (5213), AP Physics 2 (5214), AP Physics C-Mechanics (5216), AP Physics C-Elec. & Magnetism (5217), AP Biology (5035), AP Environmental Science (5121)	
PLTW-Engineering Design and Development-Capstone (8716)	120
Total—12 Courses	**Total Program hours-1440**

Digital Electronics Detailed Outline

Unit 1 Fundamentals of Analog and Digital Electronics (32 Total Days)

Lesson 1.1 Foundations and the Board Game Counter (9 days)

Understandings Addressed in Lesson:

1. Safety is an important concept that must be considered for the safety of the individual, class, and overall environment of the classroom/laboratory.

2. Electricity, even at the nominal levels used in this curriculum, can cause bodily harm or even death.

3. Engineers and technicians 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.

4. Manufacturers of resistors and capacitors use an accepted industry standard to label the nominal value of resistors and capacitors.

5. Soldering is the process of joining two metal surfaces together to form an electrical connection. Soldering is used extensively in the assembly of electronic components.

6. The ability to properly solder electronic components and recognition of improper solder connections is an important skill for engineers and technicians.

Lesson 1.2 Introduction to Analog (11 days)

Understandings Addressed in Lesson:

1. Analog and digital signals have different waveforms with distinctive characteristics.

2. Digital signals have two well-defined voltage levels, one for logic high and one for a logic low.

3. Analog signals have an infinite number of voltage levels that vary continuously over the voltage range for that particular system.

4. The atomic structure of a material determines whether it is a conductor, an insulator, or a semiconductor.

5. An understanding of the basics of electricity requires the understanding of three fundamental concepts of voltage, current, and resistance

6. Engineers and technicians use Circuit Design Software as a tool to verify functionality of their analog and digital designs.

Lesson 1.3 Introduction to Digital (12 days)

Understandings Addressed in Lesson:

1. The manufacturer datasheet contains a logic gate's general description, connection diagram, and function table.
2. Integrated circuits are categorized by their underlying circuitry, scale of integration, and packaging style.
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.
4. Logic gates are depicted by their schematic symbol, logic expression, and truth table.
5. The input and output values of combinational and sequential logic function differently.
6. Combinational logic designs implemented with AND gates, OR gates and INVERTER gates are referred to as AOI designs.
7. The flip-flop is the fundamental building block of sequential logic.

Unit 2 Combinational Logic (60 Total Days)

Lesson 2.1 Introduction to AOI Logic (20 days)

Understandings Addressed in Lesson:

1. An understanding of the binary number system and its relationship to the decimal number system is essential in the combinational logic design process.
2. The first step in designing a combinational logic circuit is to translate a set of design specifications into a truth table.
3. A truth table describes the behavior of a combinational logic design by listing all possible input combinations and the desired output for each.
4. Logic expressions can be derived from a given truth table; likewise, a truth table can be constructed from a given logic expression.
5. All logic expressions can be expressed in one of two forms: sum-of-products (SOP) or products of sum (POS).
6. All logic expressions, whether simplified or not, can be implemented using AND, OR, & Inverter Gates.
7. There is a formal design process for translating a set of design specifications into a functional combinational logic circuit.

Lesson 2.2 Introduction to NAND and NOR Logic (14 days)

Understandings Addressed in Lesson:

1. Karnaugh Mapping is a graphical technique for simplifying logic expressions containing two, three, and four variables.

2. A don't care condition is a situations where the design specifications "don't care" what the output is for one or more input conditions. Don't care conditions in K-Maps can lead to significantly simpler logic expressions and circuit implementations.

3. 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.

4. 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.

5. There is a formal design process for translating a set of design specifications into a functional combinational logic circuit implement with NAND or NOR gates.

6. Combinational logic designs implemented with NAND gates or NOR gates will typically require fewer Integrated Circuits (IC) than AOI equivalent implementations.

Lesson 2.3 Date of Birth Design (9 days)

Understandings Addressed in Lesson:

1. Seven-segment displays are used to display the digits 0-9 as well as some alpha characters.

2. The two varieties of seven-segment displays are common cathode and common anode.

3. Any combinational logic expression can be implemented with AOI, NAND, or NOR logic.

4. A formal design process exists for translating a set of design specifications into a functional combinational logic circuit.

Lesson 2.4 Specific Comb Logic Circuits & Miscellaneous Topics (8 days)

Understandings Addressed in Lesson:

1. An understanding of the hexadecimal and octal number systems and their relationship to the decimal number system is necessary for comprehension of digital electronics.

2. XOR and XNOR gates can be used to implement combinational logic circuits, but their primary intended purpose is for implementing binary adder circuits.

3. The addition of two binary numbers of any bit length can be accomplished by cascading one half-adder with one or more full adders.

4. Multiplexer/de-multiplexer pairs are most frequently used when a single connection must be shared between multiple inputs and multiple outputs.

5. Electronics displays that use multiple seven-segment display utilize de-multiplexers to significantly reduce the amount of power required to operate the display.

6. Two's complement arithmetic is the most commonly used method for handling negative numbers in digital electronics.

Lesson 2.5 Programmable Logic – Combinational (9 days)

Understandings Addressed in Lesson:

1. Engineers and technicians use Circuit Design Software to enter and synthesize digital designs into programmable logic devices.

2. Programmable logic devices can be used to implement combinational logic circuits.

3. Circuits implemented with programmable logic devices require significantly less wiring than discrete logic, but they typically require a dedicated printed circuit board to hold the device.

4. Programmable logic devices can be used to implement any combinational logic circuits but are best suited for larger, more complex designs.

Unit 3 Sequential Logic (56 Total Days)

Lesson 3.1 Latches & Flip-Flops (6 days)

Understandings Addressed in Lesson:

1. The flip-flop and transparent latch are logic devices that have the capability to store data and can act as a memory device.

2. Flip-flops and transparent latches have both synchronous and asynchronous inputs.

3. Flip-flops can be used to design single event detection circuits, data synchronizers, shift registers, and frequency dividers.

Lesson 3.2 Asynchronous Counter (14 days)

Understandings Addressed in Lesson:

1. 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.

2. Asynchronous counters can be implemented using small scale integrated (SSI) and medium scale integrated (MSI) logic gates.

3. Asynchronous counters can be implemented with either D or J/K flip-flops.

4. Up counters, down counters, and modulus counters all can be implemented using the asynchronous counter method.

Lesson 3.3 Synchronous Counters (14 days)

Understandings Addressed in Lesson:

1. Synchronous counters, also called parallel counters, are characterized by an external signal clocking all flip-flops simultaneously.

2. Synchronous counters can be implemented using small scale integrated (SSI) and medium scale integrated (MSI) logic gates.

3. Synchronous counters can be implemented with either D or J/K flip-flops.

4. Up counters, down counters, and modulus counters all can be implemented using the synchronous counter method.

Lesson 3.4 Introduction to State-Machine Design (20 days)

Understandings Addressed in Lesson:

1. A state machine is a circuit design that sequences through a set of predetermined states controlled by a clock and other input signals.

2. State machines are used to control common everyday devices such as elevator doors, traffic lights, and combinational (electronics) locks.

3. State machines can be implemented in one of two variations: Mealy or Moore.

4. State machines can be implemented using small and medium scale integrated gates and programmable logic devices.

Unit 4: Microcontrollers (29 Total Days) Optional (2013-2014)

Lesson 4.1 Introduction to Microcontrollers (9 days)

Understandings Addressed in Lesson:

1. Flowcharting is a powerful graphical organizer used by technicians, computer programmers, engineers, and professionals in a variety of roles and responsibilities.

2. Basic programming skills include variable declaration, loops, and debugging.

3. Programming languages have their own grammar, called syntax.

4. Many everyday products use microcontrollers.

5. Variables used in programming are declared and given a size that is expressed in binary.

Lesson 4.2 Microcontrollers – Boe-Bot (9 days)

Understandings Addressed in Lesson:

1. Microcontrollers are used to control many everyday products like robots, garage door openers, traffic lights, and home thermostats.
2. A servo motor is one that delivers continuous motion at various speeds.
3. Microcontrollers can be programmed to sense and respond to outside stimuli

Lesson 4.3 Boe-Bot Design Projects (11 days)

Understandings Addressed in Lesson:

1. Digital devices are only relevant if they can interact with the real world.
2. Digital control devices are increasingly necessary for mechanical systems.
3. Realistic problem solving with a control system requires the ability to interface analog inputs and outputs with a digital device.
4. Microcontrollers are a practical tool for controlling a mechanical system.