EL DORADO UNION HIGH SCHOOL DISTRICT

EDUCATIONAL SERVICES

Course of Study Information Page

COURSE TITLE **Principles of Engineering (POE) PLTW**	
DISTRICT COURSE NUMBER **#0536**	4-DIGIT STATE COURSE CODE (COMPLETED BY SILT) **5573**
Rationale:	The Project Lead The Way (PLTW) pathway to Engineering program is a sequence of courses which follows a proven hands-on, real-world, problem-solving approach to learning. The program is designed to prepare students to pursue a post-secondary education and careers in STEM-related fields.
Course Description that will be in the Course Directory:	The major focus of POE is the design process and its application. Through hands-on projects, students apply engineering standards and document their work. Students use industry standard 3D modeling software to help them design solutions to solve proposed problems, document their work using an engineer's notebook, and communicate solutions to peers and members of the professional community.
How Does this Course align with or meet State and District content standards?	
NCLB Core Subjects:	*Select up to two that apply:* ☐ Arts ☐ Economics ☐ English ☐ Foreign Language ☐ Geography ☐ Civics and Government ☐ History ☐ Mathematics ☐ Reading / Language Arts ☐ Science ☒ Not Core Subject
CDE CALPADS Course Descriptors: (See Page 2 for Definitions)	CTE TECH PREP COURSE INDICATORS: ☐ Tech Prep (32) (Higher Ed) ☐ Tech Prep & ROP(33) (Higher Ed) ☐ ROP (30) ☒ N/A CTE COURSE CONTENT CODE: ☒ CTE Introductory (01) ☐ CTE Concentrator (02) ☐ CTE Completer (03) ☐ Voc Subject _____ ☐ N/A INSTRUCTIONAL LEVEL CODE: ☐ Remedial (35) ☐ Honors UC-Certified (39) ☐ Honors Non UC-Certified (34) ☐ College (40) ☒ N/A
Length of Course:	☒ Year ☐ Semester
Grade Level(s):	☒ 9 ☒ 10 ☒ 11 ☒ 12
Credit:	☒ Number of credits: **10** ☐ Meets graduation requirements (subject _____) ☒ Request for UC "a–g" requirements CSU/UC requirement **"G"** ☐ College Prep
Prerequisites:	None
Department(s):	Non-Departmental
District Sites:	UMHS
Board of Trustees COS Adoption Date:	
Textbooks / Instructional Materials:	

Funding Source:	
Board of Trustees Textbook Adoption Date:	

Definitions

CALPADS	California Longitudinal Pupil Achievement Data System
CTE Technical Prep	A course within a CTE technical career pathway or program that has been articulated with a postsecondary education or through an apprenticeship program of at least 2 years following secondary instruction.
Instructional Level Code	Represents a nonstandard instructional level at which the content of a specific course is either above or below a ‘standard’ course instructional level. These levels may be identified by the actual level of instruction or identified by equating the course content and level of instruction with a state or nationally recognized advanced course of study, such as IB or AP.
Instructional Level Honors, UC Certified	Includes all AP courses.
Instructional Level Honors, non UC Certified	Requires Board approval.
Instructional Level College	Includes ACE courses. Equivalent to college course and content, but not an AP course. Not related to section, but to course.

Principles Of Engineering (POE) Detailed Outline (#0536)

Unit 1: Energy and Power

Lesson 1.1 Mechanisms

Understandings:

1. Engineers and engineering technologists apply math, science, and discipline-specific skills to solve problems.
2. Engineering and engineering technology careers offer creative job opportunities for individuals with a wide variety of backgrounds and goals.
3. Technical communication can be accomplished in oral, written, and visual forms and must be organized in a clear and concise manner.
4. Most mechanisms are composed of gears, sprockets, pulley systems, and simple machines.
5. Mechanisms are used to redirect energy within a system by manipulating force, speed, and distance.
6. Mechanical advantage ratios mathematically evaluate input work versus output work of mechanisms.

Knowledge and Skills

It is expected that students will:

- Differentiate between engineering and engineering technology.
- Conduct a professional interview and reflect on it in writing.
- Identify and differentiate among different engineering disciplines.
- Measure forces and distances related to mechanisms.
- Distinguish between the six simple machines, their attributes, and components.
- Calculate mechanical advantage and drive ratios of mechanisms.
- Design, create, and test gear, pulley, and sprocket systems.
- Calculate work and power in mechanical systems.
- Determine efficiency in a mechanical system.
- Design, create, test, and evaluate a compound machine design.

Lesson 1.2 Energy Sources

Understandings:

1. Energy source classifications include nonrenewable, renewable, and inexhaustible.
2. Energy source processes include harnessing, storing, transporting, and converting.
3. Energy often needs to be converted from one form to another to meet the needs of a given system.
4. An understanding of work, energy, and power is required to determine system efficiency.
5. An understanding of the basics of electricity requires the understanding of three fundamental Understandings of voltage, current, and resistance.
6. The atomic structure of a material determines whether it is a conductor, an insulator, or a semiconductor.

Knowledge and Skills

It is expected that students will:

- Identify and categorize energy sources as nonrenewable, renewable, or inexhaustible.
- Create and deliver a presentation to explain a specific energy source.
- Summarize and reflect upon information collected during a visit to a local utility company.
- Define the possible types of power conversion.
- Calculate work and power.
- Demonstrate the correct use of a digital multimeter.
- Calculate power in a system that converts energy from electrical to mechanical.
- Determine efficiency of a system that converts an electrical input to a mechanical output.
- Calculate circuit resistance, current, and voltage using Ohm’s law.
- Understand the advantages and disadvantages of parallel and series circuit design in an application.

Lesson 1.3 Energy Applications

Understandings:

1. Energy management is focused on efficient and accessible energy use.

2. System energy requirements must be understood in order to select the proper energy source.
3. Energy systems can include multiple energy sources that can be combined to convert energy into useful forms.
4. Hydrogen fuel cells create electricity and heat through an electrochemical process that converts hydrogen and oxygen into water.
5. Solar cells convert light energy into electricity by using photons to create electron flow.
6. Thermodynamics is the study of the effects of work, thermo energy, and energy on a system.
7. Thermo energy can transfer via convection, conduction, or radiation.
8. Material conductivity, resistance, and energy transfer can be calculated.

Knowledge and Skills

It is expected that students will:

- Test and apply the relationship between voltage, current, and resistance relating to a photovoltaic cell and a hydrogen fuel cell.
- Experiment with a solar hydrogen system to produce mechanical power.
- Design, construct, and test recyclable insulation materials.
- Test and apply the relationship between R-values and recyclable insulation.
- Complete calculations for conduction, R-values, and radiation.

Lesson 1.4 Design Problem – Energy and Power

Understandings:

1. Design problems can be solved by individuals or in teams.
2. Engineers use a design process to create solutions to existing problems.
3. Design briefs are used to identify the problem specifications and to establish project constraints.
4. Teamwork requires constant communication to achieve the desired goal.
5. Design teams conduct research to develop their knowledge base, stimulate creative ideas, and make informed decisions.

Knowledge and Skills

It is expected that students will:

- Brainstorm and sketch possible solutions to an existing design problem.
- Create a decision-making matrix for a design problem.

- Select an approach that meets or satisfies the constraints provided in a design brief.
- Create a detailed pictorial sketch or use 3D modeling software to document the best choice, based upon the design team's decision matrix.
- Present a workable solution to the design problem.

Unit 2: Materials and Structures

Lesson 2.1 Statics

Understandings:

1. Laws of motion describe the interaction of forces acting on a body.
2. Structural member properties including centroid location, moment of inertia, and modulus of elasticity are important considerations for structure design.
3. Static equilibrium occurs when the sum of all forces acting on a body are equal to zero.
4. Applied forces are vector quantities with a defined magnitude, direction, and sense, and can be broken into vector components.
5. Forces acting at a distance from an axis or point attempt or cause an object to rotate.
6. In a statically determinate truss, translational and rotational equilibrium equations can be used to calculate external and internal forces.
7. Free body diagrams are used to illustrate and calculate forces acting upon a given body.

Knowledge and Skills

It is expected that students will:

- Create free body diagrams of objects, identifying all forces acting on the object.
- Mathematically locate the centroid of structural members.
- Calculate moment of inertia of structural members.
- Differentiate between scalar and vector quantities.
- Identify magnitude, direction, and sense of a vector.
- Calculate the X and Y components given a vector.
- Calculate moment forces given a specified axis.
- Use equations of equilibrium to calculate unknown forces.
- Use the method of joints strategy to determine forces in the members of a statically determinate truss.

Lesson 2.2 Material Properties

Understandings:

1. Materials are the substances with which all objects are made.
2. Materials are composed of elements and area categorized by physical and chemical properties.
3. Materials consist of pure elements. Compounds and mixtures and are typically classified as metallic, ceramic, organic, polymeric, and composite.
4. Material properties including recyclability and cost are important considerations for engineers when choosing appropriate materials for a design.
5. Material selection is based upon mechanical, thermal, electromagnetic, and chemical properties.
6. Raw materials undergo various manufacturing processes in the production of consumer goods.

Knowledge and Skills

It is expected that students will:

- Investigate specific material properties related to a common household product.
- Conduct investigative non-destructive material property tests on selected common household products. Property testing conducted to identify continuity, ferrous metal, hardness, and flexure.
- Calculate weight, volume, mass, density, and surface area of selected common household product
- Identify the manufacturing processes used to create the selected common household product.
- Identify the recycling codes.
- Promote recycling using current media trends.

Lesson 2.3 Material Testing

Understandings:

1. Engineers utilize a design process and mathematical formulas to solve and document design problems.
2. Material testing aids in determining a product's reliability, safety, and predictability in function.
3. Engineers perform destructive and non-destructive tests on material specimens for the purpose of identifying and verifying the properties of various materials.
4. Material testing provides a reproducible evaluation of material properties.
5. Tensile testing data is used to create a test sample stress strain curve.

6. Stress strain data points are used to identify and calculate sample material properties including elastic range, proportional limit, modulus of elasticity, elastic limit, resilience, yield point, plastic deformation, ultimate strength, failure, and ductility.

Knowledge and Skills

It is expected that students will:

- Utilize a five-step technique to solve word problems.
- Obtain measurements of material samples.
- Tensile test a material test sample.
- Identify and calculate test sample material properties using a stress strain curve.

Lesson 2.4 Design Problem – Materials and Structures

Understandings:

1. Design problems can be solved by individuals or in teams.
2. Engineers use a design process to create solutions to existing problems.
3. Design briefs are used to identify the problem specifications and establish project constraints.
4. Teamwork requires constant communication to achieve the desired goal.
5. Design teams conduct research to develop their knowledge base, stimulate creative ideas, and make informed decisions.

Knowledge and Skills

It is expected that students will:

- Brainstorm and sketch possible solutions to an existing design problem.
- Create a decision making matrix for the design problem.
- Select an approach that meets or satisfies the constraints given in a design brief.
- Create a detailed pictorial sketch or use 3D modeling software to document the best choice, based upon your team's decision matrix.
- Present a workable design solution.

Unit 3: Control Systems

Lesson 3.1 Machine Control

Understandings:

1. Flowcharts provide a step by step schematic representation of an algorithm or process.
2. Control systems are designed to provide consentient process control and reliability.
3. Control system protocols are an established set of commands or functions typically created in a computer programming language.
4. Closed loop systems use digital and analog sensor feedback to make operational and process decisions.
5. Open loop systems use programming constants such as time to make operational and process decisions.

Knowledge and Skills

It is expected that students will:

- Create detailed flow charts utilizing a computer software application.
- Create control system operating programs utilizing computer software.
- Create system control programs that utilize flowchart logic.
- Choose appropriate inputs and output devices based on the need of a technological system.
- Differentiate between the characteristics of digital and analog devices.
- Judge between open and closed loop systems in order to choose the most appropriate system for a given technological problem.
- Design and create a control system based on given needs and constraints.

Lesson 3.2 Fluid Power

Understandings:

1. Fluid power systems are categorized as either pneumatic, which utilizes gas, or hydraulic, which utilizes liquid.
2. Fluid power is possible because in a system of confined fluid, pressure acts equally in all directions.
3. The most basic components of all fluid power systems include a reservoir or receiver, a pump or compressor, a valve, and a cylinder.
4. Fluid power systems are designed to transmit force over great distances, multiply an input force, and increase the distance that an output will move.
5. Laws about the behavior of fluid systems and standard conventions for calculating values within fluid systems aid in the design and understanding of such systems.
6. Standard schematic symbols and conventions are used to communicate fluid power designs.

Knowledge and Skills

It is expected that students will:

- Identify devices that utilize fluid power.
- Identify and explain basic components and functions of fluid power devices.
- Differentiate between the characteristics of pneumatic and hydraulic systems.
- Distinguish between hydrodynamic and hydrostatic systems.
- Design, create, and test a hydraulic device.
- Design, create, and test a pneumatic device.
- Calculate values in a fluid power system utilizing Pascal's Law.
- Distinguish between pressure and absolute pressure.
- Distinguish between temperature and absolute temperature.
- Calculate values in a pneumatic system, utilizing the perfect gas laws.
- Calculate flow rate, flow velocity, and mechanical advantage in a hydraulic system.

Lesson 3.3 Design Problem – Control Systems

Understandings:

1. Design problems can be solved by individuals or in teams.
2. Engineers use a design process to create solutions to existing problems.
3. Design briefs are used to identify the problem specifications and to establish project constraints.
4. Teamwork requires constant communication to achieve the desired goal.
5. Design teams conduct research to develop their knowledge base, stimulate creative ideas, and make informed decisions.

Knowledge and Skills

It is expected that students will:

- Brainstorm and sketch possible solutions to an existing design problem.
- Create a decision-making matrix for a design problem.
- Select an approach that meets or satisfies the constraints provided in a design brief.
- Create a detailed pictorial sketch or use 3D modeling software to document the best choice, based upon the design team's decision matrix.
- Present a workable solution to the design problem.

Unit 4: Statistics and Kinematics

Lesson 4.1 Statistics

Understandings:

1. Engineers use statistics to make informed decisions based upon established principles.
2. Visual representations of data analyses allow for easy distribution and understanding of data.
3. Statistics is based upon both theoretical and experimental data analysis.

Knowledge and Skills

It is expected that students will:

- Calculate the theoretical probability that an event will occur.
- Calculate the experimental frequency distribution of an event occurring.
- Apply the Bernoulli process to events that only have two distinct possible outcomes.
- Apply AND, OR, and NOT logic to probability.
- Apply Bayes' theorem to calculate the probability of multiple events occurring.
- Create a histogram to illustrate frequency distribution.
- Calculate the central tendency of a data array, including mean, median, and mode.
- Calculate data variation, including range, standard deviation, and variance.

Lesson 4.2 Kinematics

Understandings:

1. When working with bodies in motion, engineers must be able to differentiate and calculate distance, displacement, speed, velocity, and acceleration.
2. When air resistance is not taken into account, released objects will experience acceleration due to gravity, also known as freefall.
3. Projectile motion can be predicted and controlled using kinematics equations.
4. When a projectile is launched, velocity in the x direction remains constant; whereas, with time, the velocity in the Y direction in magnitude and direction changes due to gravity.

Knowledge and Skills

It is expected that students will:

- Calculate distance, displacement, speed, velocity, and acceleration from data.
- Design, build, and test a vehicle that stores and releases potential energy for propulsion.

- Calculate acceleration due to gravity given data from a free fall device.
- Calculate the X and Y components of a projectile motion.
- Determine the angle needed to launch a projectile a specific range given the projectile’s initial velocity.

"PLTW classes focus on hands-on and real-life experience. What I liked the most about these classes was having the freedom of designing my final project. I can only encourage other students to take PLTW courses, challenge themselves, and remember that no dream is unattainable."

Cheyla Moranchel, PLTW Engineering student, Class of 2014
John F. Kennedy High School, Mt. Angel, Oregon

Preparing Students for the Global Economy

Project Lead The Way (PLTW) is a 501(c)(3) nonprofit organization and the nation's leading provider of K-12 STEM programs. Through world-class, activity-, project-, and problem-based curriculum, high-quality teacher professional development, and an engaged network of educators and corporate partners, PLTW helps students develop the skills needed to succeed in our global economy.

PLTW courses are aligned with Common Core State Standards for Math and English Language Arts, Next Generation Science Standards, and other national and state standards. Courses and units are designed to complement math and science courses, and in some instances, are used as the core curriculum.

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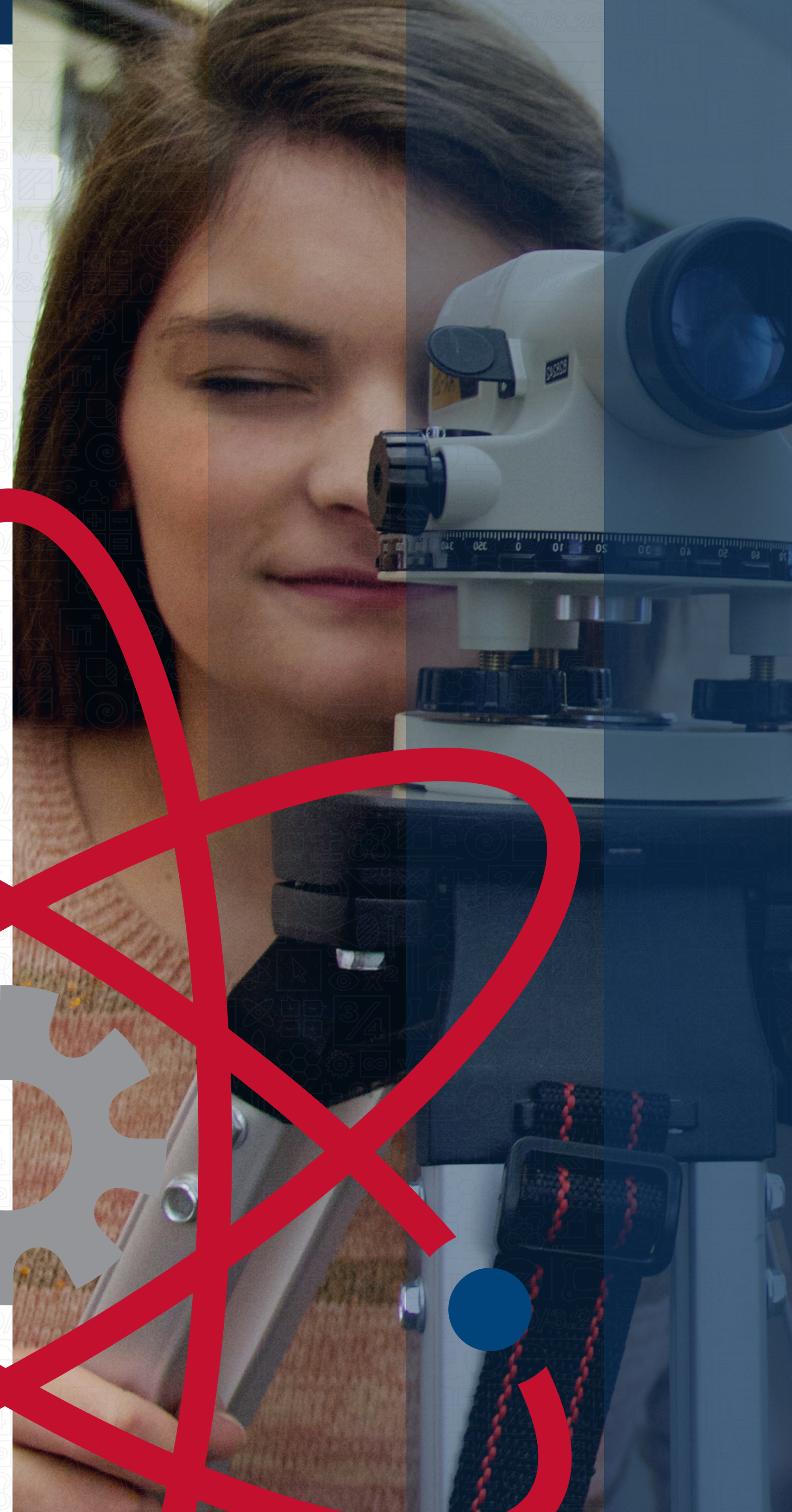
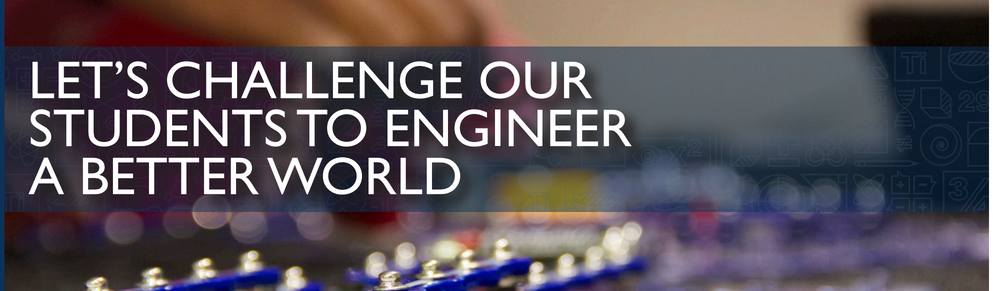


PLTW | Engineering

Design for a Successful Future Awaits



LET'S CHALLENGE OUR STUDENTS TO ENGINEER A BETTER WORLD

The influence of engineering is extensive. Engineering drives lofty innovations, such as space flight, and accessible yet significant breakthroughs, like greener household appliances. Today's students have limitless potential to build on such progress – when equipped with a strong early interest, critical-thinking skills, and problem-solving competencies.

With current projections indicating that more than 1.2 million U.S. jobs in science, technology, engineering, and math (STEM) will go unfilled by 2018, the time to expand the engineering talent pool is now.

Engaging student interest is imperative, as studies have shown that 75 percent of students talented in math and science during their K – 12 years decide not to pursue STEM in college. In addition, the field of engineering is grappling with an underutilization of potential resources: Only 13 percent of American engineers are women, while underrepresented minorities account for just 12 percent of the engineering workforce.

How can we engage student interest and equip all students with the skills needed for a brighter future?

PLTW Engineering

PLTW Engineering™ is more than just another high school engineering program. It is about applying science, technology, engineering, and math through a project-based, hands-on approach to solve complex, open-ended problems in a real-world context. Students focus on the process of defining and solving a problem, not on getting the "right" answer. They learn how to apply STEM knowledge, skills, and habits of mind to make the world a better place through innovation.

PLTW students say that PLTW Engineering influenced their post-secondary decisions and helped shape their future. PLTW students are shown to study engineering and other STEM disciplines at a rate significantly higher than their non-PLTW peers.

Even for students who do not plan to pursue engineering after high school, the PLTW Engineering program provides opportunities to develop highly transferable skills in critical thinking, collaboration, and problem solving, which are relevant for any coursework or career.

U.S. News STEM Solutions Summit, 2012; Infographic: The Math-Science Shortage, Getting Smart, 2011; U.S. Census Bureau, "Disparities in STEM Employment by Sex, Race, and Hispanic Origin", 2013

PLTW Engineering Curriculum

Foundation Courses

IED **Introduction to Engineering Design** *1 year*
Students dig deep into the engineering design process, applying math, science, and engineering standards to hands-on projects. They work both individually and in teams to design solutions to a variety of problems using 3-D modeling software and use an engineering notebook to document their work.

POE **Principles of Engineering** *1 year*
Through problems that engage and challenge, students explore a broad range of engineering topics, including mechanisms, the strength of structures and materials, and automation. Students develop skills in problem solving, research, and design while learning strategies for design process documentation, collaboration, and presentation.

Specialization Courses

AE **Aerospace Engineering** *1 year*
This course propels students' learning in the fundamentals of atmospheric and space flight. As they explore the physics of flight, students bring the concepts to life by designing an airfoil, propulsion system, and rockets. They learn basic orbital mechanics using industry-standard software. They also explore robot systems through projects such as remotely operated vehicles.

BioE **Biological Engineering** *1 year*
Beginning in the 2015-16 school year with Core Training in Summer 2015
BioE develops students' thinking skills and prepares them for emerging careers through topics such as genetic engineering, biofuels, and biomanufacturing. *BioE will replace Biotechnical Engineering (BE), which PLTW will continue to offer until the end of the 2016-17 school year. BE End of Course Assessments will no longer be available after spring 2015.*

CEA **Civil Engineering and Architecture** *1 year*
Students learn important aspects of building and site design and development. They apply math, science, and standard engineering practices to design both residential and commercial projects and document their work using 3D architecture design software.

CIM **Computer Integrated Manufacturing** *1 year*
Manufactured items are part of everyday life, yet most students have not been introduced to the high-tech, innovative nature of modern manufacturing. This course illuminates the career opportunities related to understanding manufacturing. At the same time, it teaches students about manufacturing processes, product design, robotics, and automation.

CSE **Computer Science and Software Engineering** *1 year**
This course aims to develop computational thinking, generate excitement about career paths that incorporate computing, and introduce professional tools that foster creativity and collaboration.

DE **Digital Electronics** *1 year*
From smart phones to appliances, digital circuits are all around us. This course provides a foundation for students who are interested in electrical engineering, electronics, or circuit design. Students study topics such as combinational and sequential logic and are exposed to circuit design tools used in industry, including logic gates, integrated circuits, and programmable logic devices.

Capstone Course

EDD **Engineering Design and Development** *1 year*
The knowledge and skills students acquire throughout PLTW Engineering come together in EDD as they identify an issue and then research, design, and test a solution, ultimately presenting their solution to a panel of practicing engineers. Students apply the professional skills they have developed to document a design process, and they complete EDD ready to take on any post-secondary program or career.

**PLTW Computer Science program foundation course. Aligns with CSTA 3B standards.*