

CIVIL ENGINEERING AND ARCHITECTURE

Civil Engineering and Architecture introduces students to the fundamentals of design and aspects of the fields of civil engineering and architecture. Throughout the course, students will manipulate computer-aided design (CAD) software to design and create plans associated with a residential and commercial structure. Application of basic design principles associated with discipline specific fields of architecture and concepts of civil engineering will be used in their design. This course will emphasize the environmental impact of a structure and the building process, treatment of water sources before/during and after construction of a structure, building construction, surveying, universally compliant building design, calculations associated with the building process, introduction to basic mechanical, electrical and plumbing (MEP) systems concepts within a building and the application of building codes as established at the local, state and national levels.

- PLTW DOE Course Code: 4820
- Non-PLTW DOE Course Code: 5650
- Recommended Grade Level: 11, 12
- Recommended Prerequisites: Introduction to Engineering Design and Principles of Engineering
- Credits: 2 semester course, 2 semesters required, 1 credit per semester, 2 credits maximum
- Counts as a Directed Elective or Elective for all diplomas
- Qualifies as a quantitative reasoning course
- If PLTW curriculum is used, PLTW training is required of the teacher.

Dual Credit

This course provides the opportunity for dual credit for students who meet postsecondary requirements for earning dual credit and successfully complete the dual credit requirements of this course.

Application of Content and Multiple Hour Offerings

Intensive laboratory applications are a component of this course and may be either school based or work based or a combination of the two. Work-based learning experiences should be in a closely related industry setting. Instructors shall have a standards-based training plan for students participating in work-based learning experiences.

Implementation Guidance

Domain Zero (0) was created much like a process standard to be implemented throughout the length of the course. These standards should be taught in conjunction with Content Area Standards in Domains 1-7.

Career and Technical Student Organizations (CTSOs)

Career and Technical Student Organizations are considered a powerful instructional tool when integrated into Career and Technical Education programs. They enhance the knowledge and skills students learn in a course by allowing a student to participate in a unique program of career and leadership development. Students should be encouraged to participate in a Career and Technical Student Organization, such as the Technology Student Association (TSA)

Domain 0 – Project Management

Core Standard 1 *Students will exhibit appropriate safety practices while working with tools and equipment.*

- ETE – 0.1.1 Demonstrate relevant safety practices when using tools and equipment as determined by task, materials, environment, and protective attire.
- ETE – 0.1.2 Apply corrective action(s) to eliminate hazards.
Understand the format and content of industry based Material Safety Data Sheets (MSDS).

Core Standard 2 *Students will investigate various careers within the fields of engineering and technology.*

- ETE – 0.2.1 Identify engineering and technology occupations and the roles and responsibilities of each.
- ETE – 0.2.2 Report job outlook, demand, and projected wages for engineering and technology careers.
- ETE – 0.2.3 Explore job opportunities that are available in engineering and technology.
- ETE – 0.2.4 Investigate post-secondary training opportunities and industry certifications that are available.
- ETE – 0.2.5 Explore student professional organizations related to engineering and technology.

Core Standard 3 *Students will communicate the design process.*

- ETE - 0.3.1 Explain the importance of documentation.
- ETE - 0.3.2 Apply sketching and annotation skills to document work.
- ETE - 0.3.3 Produce working drawings using appropriate drawing styles and techniques.
- ETE - 0.3.4 Construct design models or finish models to display concepts of design or theory investigated.
- ETE - 0.3.5 Document project components into an engineering notebook (digital or paper).
- ETE - 0.3.6 Communicate technical knowledge in a variety of formats.
- ETE – 0.3.7 Utilize presentation software to create a presentation that outlines team or individual priorities for design and share with peers.
- ETE-0.3.8 Document best work in a portfolio (digital or paper).

Core Standard 4 *Students will apply appropriate research techniques.*

- ETE - 0.4.1 Formulate unbiased research questions to collect information/data.
- ETE - 0.4.2 Apply appropriate investigative strategies.
- ETE - 0.4.3 Evaluate sources appropriate for academic research.
- ETE - 0.4.4 Select resources relevant to the identified problem.
- ETE - 0.4.5 Synthesize information collected during the research process.
- ETE - 0.4.6 Generate a list of sources used to gather information using APA or MLA format.

Content Standards

Domain – History in Architecture and Civil Engineering

Core Standard 1 Students evaluate historical structures to understand the evolution of design elements, structural components and material used.

Standards

- CEA-1.1 Identify and describe multiple architectural styles that are major milestones in the design and development of structures.
- CEA-1.2 Analyze the influence technology innovations have had on the design and construction of structures.
- CEA-1.3 Identify advancements related to architectural design, engineering, and technological advancements through history and how those innovations have changed the way structures are designed.
- CEA-1.4 Compare modern structural and architectural design to historical designs.

Domain – Architectural Design, Cost & Efficiency

Core Standard 2 Students assess architectural design to incorporate the use of spatial relationships, building layout, and costs into a design project.

Standards

- CEA-2.1 Describe connections between architectural disciplines and engineering disciplines and their roles in the design and construction process.
- CEA-2.2 Demonstrate the importance of focusing on detail when executing the design process.
- CEA-2.3 Examine concepts related to the Principles of Design and Elements of Design.
- CEA-2.4 Apply the steps of the design process to solve a variety of architectural design problems.
- CEA-2.5 Demonstrate the use of math skills to calculate material costs associated with the construction of commercial and residential structures.
- CEA-2.6 Demonstrate how to calculate basic heat loss/heat gain of a structure.
- CEA-2.7 Identify and describe common materials used in the construction of a building or residential structure.
- CEA-2.8 Identify and implement the use of Universal Design principles as part of a design solution.
- CEA-2.9 Analyze and incorporate sustainable building practices into a design solution.
- CEA-2.10 Interpret and use an engineering and architectural scale to measure and determine sizes of elements on a printed drawing.
- CEA-2.11 Recognize and distinguish the basic types of floor plans styles associated with architectural design.

Domain – Residential Building Design

Core Standard 3 Students establish a base knowledge of residential design concepts to develop a set of construction documents.

Standards

- CEA-3.1 Develop a program and scope document to identify a client’s needs for a residential structure.
- CEA-3.2 Apply basic design guidelines and practices for the development of private, public and services spaces within a residential structure.
- CEA-3.3 Develop and document a plot plan or site plan for a residence considering drainage, property improvements, utilities and dwelling footprint.
- CEA-3.4 Design and document footings and foundations for a residential structure.
- CEA-3.5 Design and document a residential floor plan using the accepted industry standards related to drawing scale, symbols, annotation and drawing techniques.
- CEA-3.6 Design and document exterior and interior elevations.
- CEA-3.7 Identify the appropriate materials to be used in residential construction in accordance to geographical location, building codes, and style of dwelling.
- CEA-3.8 Analyze and apply building codes and zoning codes for use in constructing a residential structure.
- CEA-3.9 Identify components of residential framing systems.
- CEA-3.10 Determine the advantages and disadvantages between different residential roof designs per geographical location and client design requirements.
- CEA-3.11 Analyze a residential structure to identify how the implementation of green architecture in the design and construction impact the environment.
- CEA-3.12 Utilize computer-aided design (CAD) software to develop design and construction documentation for a residential structure.
- CEA-3.13 Design and document required details and sections associated with a residential structures.

Domain – Commercial Building Design

Core Standard 4 Students establish a base knowledge to identify commercial building materials, building codes, and design concepts to develop a set of construction documents.

Standards

- CEA-4.1 Identify and compare the similarities and the differences between commercial and residential building systems.
- CEA-4.2 Identify and compare the similarities and the differences between residential and commercial design related to local, state and national building codes.
- CEA-4.3 Evaluate zoning regulations for the allowable use of property.
- CEA-4.4 Identify the appropriate materials and their assembly to create a wall system for a commercial structure in accordance to geographical location, building codes, and style of the structure.

Domain – Structural Components and Design

Core Standard 5 Students connect through terminology and mathematics the structural components of commercial and residential design to apply loads on a structure including beams, girders, columns and footings.

Standards

- CEA-5.1 Determine the appropriate roof beams to carry the calculated load able to support the design load of a structure.
- CEA-5.2 Determine the design load conditions for beams and girders within a structure.
- CEA-5.3 Construct free body diagramming to demonstrate the structural analysis of supported beams.
- CEA-5.4 Determine required floor loading of a structure and determine how it affects support elements within a structure.
- CEA-5.5 Identify and select the proper commercial foundation systems by material and use of the system.
- CEA-5.6 Determine and analyze design loads transferred from the structure to the ground.
- CEA-5.7 Use structural analysis software to verify determined analysis of supported beams and girders.

Domain – Building Systems

Core Standard 6 Students properly size and integrate building systems related to mechanical, electrical and plumbing (MEP) disciplines while conserving natural resources for a residential and commercial structures.

Standards

- CEA-6.1 Identify code requirements for the installation of mechanical, electrical and plumbing (MEP) disciplines for a structure.
- CEA-6.2 Read and interpret mechanical, electrical and plumbing (MEP) discipline construction drawings.
- CEA-6.3 Realize the requirements by an architect to understand how mechanical, electrical and plumbing (MEP) discipline designs are design and constructed within a structure.
- CEA-6.4 Describe and analyze the appropriate options for the management of wastewater for a structure.
- CEA-6.5 Examine how the placement of utilities effect design of the structure.
- CEA-6.6 Assess mechanical, electrical and plumbing systems for energy conservation techniques determined by geographic location.

Domain – Surveying & Hydrology

Core Standard 7 Students connect land surveying equipment components and theory to architectural and civil engineering projects to evaluate how land surveying impacts design and construction.

Standards

- CEA-7.1 Analyze a site by performing a level survey.
- CEA-7.2 Classify soil samples relevant to structure designs and their effect on a foundation system.
- CEA-7.3 Analyze pre and post development stormwater run-off and implement a design solution associated with the change in stormwater run-off.
- CEA-7.4 Compare and contrast site design factors and the impacts on the environment and surrounding properties.
- CEA-7.5 Demonstrate site planning with consideration of local, state and national building codes and client program/scope requirements.
- CEA-7.6 Analyze drainage patterns, vegetation, and construction materials to determine the impact of design elements and methods to modify the surrounding terrain.
- CEA-7.7 Recognize and distinguish between the different types of surveying and key vocabulary associated with the survey discipline.
- CEA-7.8 Calculate cut and fill operations for a requirement on a site for the acquisition or disposal of soil.