Unit 2: Civil Engineering

Content Area: **Applied Technology**
Course(s):
Time Period: **Marking Period 1**
Length: **7-8 Weeks**
Status: **Published**

Brief Summary of Unit

Students will develop an understanding of civil engineering. The exploration will center on the development of a truss bridge. Students will develop a solution that requires qualitative and quantitative analysis and application of the design loop. Students will use computer software, prototyping, and evaluation to test and develop their solutions. Students will explore environmental considerations in design. Drawing conventions and advanced spreadsheets will be introduced. Students will methodically document their work and produce a bridge and a technical report.

Revision Date: July 2024

Essential Questions/Enduring Understandings

Essential Questions:

What is civil engineering, describe the jobs they perform?

How can software be used to brainstorm and design solutions to engineering problems?

What factors are considered when designing a structure?

Enduring Understandings:

Structural design involves an understanding of loads and forces.

Structural design involves an understanding of how structural materials handle loads.

Structural design involves knowledge of assembly systems.

Structural design concerns the right-sizing of materials.

Learning Plan

Preview the essential questions and connect to learning throughout the unit.

Lecture and discussion about bridges in New Jersey.

Formative assessments will be conducted throughout the course concerning unit vocabulary and essential questions using class discussion, student writing, and practice quizzes.

Lecture and demonstration about unit vocabulary and structural design principles.

Summative assessment will be conducted by the student and teacher using a rubric specific to CADD skill development.

Problem based learning: Students will develop a solution to a civil engineering problem. Example of a suitable problem: design a truss bridge with tongue depressors that meets specific criteria. Suggested software for modeling: West Point Bridge Design and Johns Hopkins Truss modeling tool, (free software and tools). Evaluation software: Microsoft Excel or Google Docs spreadsheet software. Students will maintain design logs to document their use of the design loop.

Formative assessments will be conducted throughout the design process.

Summative assessment will be conducted by the student and teacher using a rubric specific to the design problem.

Answer writing prompts.

Objectives

Students will know:

what civil engineers do.

about the history of bridges in New Jersey and general types of bridges.

the commonly established graphic conventions.

how to make orthographic multi-view projection drawings that follow conventions (Front, top and side), using traditional techniques or CADD software.

how to incorporate scale in drawings.

how the Pythagorean theorem relates to truss bridge design and prototyping.

different strategies for brainstorming.

the difference between qualitative and quantitative analysis

unit vocabulary, including but not limited to tension, compression, deflection, neutral axis, scale, pin connection, moment connection, rigid structure, truss, member, joint, slenderness ratio, Pythagorean theorem, etc.

Students will be skilled at:

how to model a bridge on the computer qualitatively

how to model a bridge on the computer quantitatively

how to prototype a truss bridge

how to safely use a drill press

how to use Excel or another spreadsheet as an analysis tool

how to use the design loop as a pathway to a solution to a technological problem

Assessment

Formative assessment:

answer the essential and guiding questions of this unit of study.

participate in guided question and answer sessions, group and individual discussions, and demonstrate an understanding of the purpose of the unit lessons and the key terms and concepts.

Create a bridge using bridge modeling software.

provide evidence of design using spreadsheet and graphing software.

provide evidence by prototyping.

use unit vocabulary in a design log and discussions and classroom interactions.

create a project report.

Summative assessment:

written quiz on drill press safety.

create a project report. written quizzes on civil engineering

invent the solution to civil engineering problems and provide a solution that is a product of application of the design loop

provide evidence in the form of a design log;

complete writing prompts. Examples: “The testing and evaluation of the bridge indicated …” “Brainstorming alternate solutions on the computer was a timesaver because…” “The most useful tool I used to design the bridge was…” “Civil engineers don’t just design bridges…”

Benchmark:

Final exam

Alternate Assessments:

Guided bridge report

Materials

Tongue depressors, glue

Weights and S-hooks

Workspace to fabricate and test and store bridges

Drill Press, Scroll saw, Power Drill , Hand tools

Safety glasses

SmartBoard Presentations. Video tapes or DVDs

Email and e-board

Websites

CAD and other software programs

Smartboard use for presentation and interactive lessons

Virtual Field Trips

Standards

9.4.12.CI	Creativity and Innovation
1	Developing Responsibility for Learning: Cultivating independence, self-reflection, and responsibility for one's own learning.
9.2.12.CAP	Career Awareness and Planning
	There are strategies to improve one's professional value and marketability.
	With a growth mindset, failure is an important part of success.
L.SS.9–10.1	Demonstrate command of the system and structure of the English language when writing or speaking.
2	Adapting Communication: Adapting communication in response to the varying demands of audience, task, purpose, and discipline.

9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
9.2.12.CAP.2	Develop college and career readiness skills by participating in opportunities such as structured learning experiences, apprenticeships, and dual enrollment programs.
4	Building Knowledge: Building strong content knowledge and connecting ideas across disciplines using a variety of text resources and media.
9.4.12.CI.2	Identify career pathways that highlight personal talents, skills, and abilities (e.g., 1.4.12prof.CR2b, 2.2.12.LF.8).
5	Leveraging Technology: Employing technology and digital media thoughtfully, strategically and capably to enhance reading, writing, speaking, listening, and language use.
	Career planning requires purposeful planning based on research, self-knowledge, and informed choices.
9.4.12.CI.3	Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1).
9.2.12.CAP.4	Evaluate different careers and develop various plans (e.g., costs of public, private, training schools) and timetables for achieving them, including educational/training requirements, costs, loans, and debt repayment.
9.4.12.CT	Critical Thinking and Problem-solving
9.2.12.CAP.5	Assess and modify a personal plan to support current interests and post-secondary plans.
	Collaboration with individuals with diverse experiences can aid in the problem-solving process, particularly for global issues where diverse solutions are needed.
L.KL.9–10.2	Apply knowledge of language to make effective choices for meaning, or style, and to comprehend more fully when reading, writing, speaking or listening.
9.4.12.CT.1	Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
9.2.12.CAP.6	Identify transferable skills in career choices and design alternative career plans based on those skills.
9.4.12.CT.2	Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
9.2.12.CAP.7	Use online resources to examine licensing, certification, and credentialing requirements at the local, state, and national levels to maintain compliance with industry requirements in areas of career interest.
9.4.12.CT.3	Enlist input from a variety of stakeholders (e.g., community members, experts in the field) to design a service learning activity that addresses a local or global issue (e.g., environmental justice).
9.4.12.CT.4	Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes.
	An individual's income and benefit needs and financial plan can change over time.
IC	Impacts of Computing
	The design and use of computing technologies and artifacts can positively or negatively affect equitable access to information and opportunities.
9.2.12.CAP.13	Analyze how the economic, social, and political conditions of a time period can affect the labor market.
TECH.K-12.1.4	Innovative Designer
	Students use a variety of technologies within a design process to identify and solve problems by creating new, useful or imaginative solutions.
TECH.K-12.1.4.a	know and use a deliberate design process for generating ideas, testing theories, creating

	innovative artifacts or solving authentic problems.
TECH.K-12.1.4.b	select and use digital tools to plan and manage a design process that considers design constraints and calculated risks.
TECH.K-12.1.4.c	develop, test and refine prototypes as part of a cyclical design process.
A.REI	Reasoning with Equations and Inequalities
A.REI.A	Understand solving equations as a process of reasoning and explain the reasoning
TECH.K-12.1.4.d	exhibit a tolerance for ambiguity, perseverance and the capacity to work with open-ended problems.
ED	Engineering Design
	Engineering design is a complex process in which creativity, content knowledge, research, and analysis are used to address local and global problems. Decisions on trade-offs involve systematic comparisons of all costs and benefits, and final steps that may involve redesigning for optimization.
8.2.12.ED.1	Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers.
8.2.12.ED.2	Create scaled engineering drawings for a new product or system and make modification to increase optimization based on feedback.
8.2.12.ED.3	Evaluate several models of the same type of product and make recommendations for a new design based on a cost benefit analysis.
8.2.12.ED.4	Design a product or system that addresses a global problem and document decisions made based on research, constraints, trade-offs, and aesthetic and ethical considerations and share this information with an appropriate audience.
	Engineering design evaluation, a process for determining how well a solution meets requirements, involves systematic comparisons between requirements, specifications, and constraints.
8.2.12.ED.5	Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints (e.g., safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, ergonomics).
8.2.12.ED.6	Analyze the effects of changing resources when designing a specific product or system (e.g., materials, energy, tools, capital, labor).
HS-ESS3	Earth and Human Activity
HS-ESS3-5	Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.
	Analyzing and Interpreting Data
ESS3.D	Global Climate Change
HS-ETS1	Engineering Design
HS-ETS1-1	Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
	Asking Questions and Defining Problems
	Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.
	Analyze complex real-world problems by specifying criteria and constraints for successful solutions.
ETS1.A	Delimiting Engineering Problems

	Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities.
HS-ETS1-2	Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. Constructing Explanations and Designing Solutions Constructing explanations and designing solutions 9–12 builds on K – experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles and theories. Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
ETS1.C	Optimizing the Design Solution Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (tradeoffs) may be needed.

Integrated Accommodation and Modifications, Special Edcuation students...

Integrated Accommodation and Modifications, Special Education students, English Language Learners, At-Risk students, Gifted and Talented students, Career Education, and those with 504s. Please see attached spreadsheet.