Honors Principles of Engineering
Grade(s) 9-12

Unit #0
Engineering Design Process

Essential Question
How do engineers and designers create and improve products used in our daily lives?

Unit Summary
In this unit, students learn and apply their understanding of the engineering design process to design a shoe to meet the specific needs of a customer. They use information gathered in interviews to learn about their client, develop a detailed problem statement, apply different brainstorming techniques, visualize their solution through concept sketches, and create a decision matrix to select the best solution for their client's needs. Students build a prototype and create a testing plan, to test and iterate their design and share their results in a detailed presentation.

Guiding Questions
Content

- What is a decision matrix and why is it used?
- What techniques do engineers use to visually present design ideas?
- What advantages does Computer-Aided Design (CAD) provide over traditional paper and pencil design?
- What advantages does paper and pencil design provide over CAD?
- What advantages does paper and pencil design provide over CAD?
- What data should be collected in a testing process?
- What data should be collected in a testing process?

Process

- How does a design team know what problem to solve?
- How do engineers communicate designs and solutions?
- How is material testing data useful?

- How can you design a product that meets the needs of a user?

Reflective

- Why is empathy an important skill in engineering design?
- Why is it important for the team to come to a consensus on the issues that arise? What are some reasons that the team leader should not dictate the direction of the group?

Priority Standards

- 1.1 Work with others as an engineering team to solve problems, with each team member having individual and collective responsibility.
- 3.3 Locate information and select the materials, tools, equipment, or other resources to perform the activities needed to accomplish a specific task using a problem-solving method.

Supporting Standards

- 2.4 Analyze test data and utilize the results to make decisions.
- 2.2 Formulate conclusions through analysis of recorded laboratory test data for presentations in the form of charts, graphs, written, verbal and multimedia formats.

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Unit #1
Mechanical Design

Essential Question
How can we use simple machines and types of motion to efficiently perform work and harness energy, and what are the trade-offs involved?

Unit Summary
Students explore the foundational elements that make up complex mechanical devices and systems. They work collaboratively to solve real-world problems using their understanding of mechanical designs and motion to develop complex mechanisms. Students gain understanding of mechanical engineering concepts such as simple machines, motion, energy, work, power, and mechanisms and apply them to solve engineering problems. Students continue to apply their project management, collaboration, communication, and additional key transportable skills throughout the unit.

Guiding Questions
Content
- What are the simple machines?
- What is energy?
- What is work?
- What is power?
- What is mechanical adv

Process
- How do engineers quantify the mechanical advantage of a system?
- How do engineers apply their knowledge of simple machines to solve problems?
- How do engineers quantify energy, work, and power?

- How do engineers apply their knowledge of energy, work, and power to solve problems?
- How are mechanisms used to convert one type of motion to another?
- How do engineers manipulate motion to solve design problems?
- How can you apply your understanding of machines and mechanisms to solve an authentic problem?

Reflective

- Why do engineers use simple machines to solve problems in our daily lives?

Priority Standards

- 3.1 Explain the functions of the six types of simple machines and use mathematics to distinguish the mechanical advantage gained by each.

Supporting Standards

- 3.3 Locate information and select the materials, tools, equipment, or other resources to perform the activities needed to accomplish a specific task using a problem-solving method.
- 2.2 Formulate conclusions through analysis of recorded laboratory test data for presentations in the form of charts, graphs, written, verbal, and multimedia formats.

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Unit #2
Application of Robotics

Essential Question
How can we use coding and technology to design and build robots to solve real-world problems and improve our lives?

Unit Summary
Students explore the world of robotics and programming. They use their understanding of mechanical design, robotics, and programming to work collaboratively to develop solutions to real-world-problems. Students learn concepts such as programming, using and applying sensors, and artificial intelligence. Students utilize their collaboration, communication, project management, and additional transportable skills throughout the unit to solve in-depth problems.

Guiding Questions
Content
- What characteristics define a robot?
- What practices do programmers use to write effective code?
- What is artificial intelligence, and how do engineers use it to solve problems?
- What are some of the ethical implications of artificial intelligence?

Process
- How do engineers use sensors to solve design problems?
- How can you apply your understanding of mechanics and programming to solve a design problem?

Reflective
- Why are robots used to perform tasks in the place of humans?

Priority Standards

- 3.3 Locate information and select the materials, tools, equipment, or other resources to perform the activities needed to accomplish a specific task using a problem-solving method.

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Unit #3
Energy in Action

Essential Question
How can we understand and harness the power of energy, electricity, and fluids to solve real-world problems and improve our lives?

Unit Summary
Students explore energy more deeply and useful applications of it through electrical circuits, fluids, and kinematics. They begin the unit by exploring the relationships between circuit components, derive formulas, and apply their understanding to solve problems. Students then move into the world of fluids, the deep mathematical principles that govern them, and apply their knowledge to design their own fluid power system. They end the unit implementing their understanding of energy in motion through kinematics. Students also continue their career exploration journey by examining the financial aspects of attending a postsecondary institution.

Guiding Questions
Content
- What are the mathematical relationships between circuit parameters?
- What impact does fluid power have on our everyday lives?
- What devices or systems might be improved with the use of fluid power?
- What are the similarities and differences of mechanical advantage in simple machines?
- What equations govern how objects move?

Process
- How do you differentiate between circuit types?
- How do you model electrical circuits?
- How do you test circuit parameters?
- How do we graph and analyze motion?

- How do we predict where projectiles will land?

Reflective

- Why are Kirchhoff's Laws important to engineers and designers of electrical circuits?
- Why are Pascal's Law, the perfect gas laws, Bernoulli's Principle, and other similar rules important to engineers and designers of fluid power systems?

Priority Standards

- 2.1 - Illustrate collected data through the use of tables, charts, and graphs
- 1.5 - Utilize materials from an assigned research topic to design and deliver a presentation.

Supporting Standards

- 0.1 - Demonstrate an understanding of industry standards for personal safety including the safe use of tools, equipment, and hazardous materials.

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Unit #4
Designing Infrastructure and Developing Sustainability

Essential Question
How is data about transportation and forces used in the planning of infrastructure of roads and building structures?

Unit Summary
They investigate methods of designing infrastructure as well as various techniques to develop sustainable practices for the future. Students gain an understanding of in-depth mathematical approaches to infrastructure design for static systems as well as apply statistical analysis and rigorous calculations to traffic and intersection design. They explore a variety of energy sources and a life cycle analysis to measure trade-offs in environmental dilemmas. Students continue to refine their project management, collaboration, communication, and additional key transportable skills to understand the impact of design choices on a large scale.

Guiding Questions
Content

- What factors impact beam deflection?)
- What are the properties of structural members and why are they useful?
- What is a centroid and how is it applied in structural members?
- What are the differences between stress and strain?
- What is a moment and how does it help solve problems in static structures?
- What are renewable and nonrenewable resources and how do humans use them?
- What factors affect the rate of flow on a roadway?
- What role does creativity have in the engineering design process?
- What do engineers do to clearly document and communicate their work? Why is this important?

Process

- How does the stress-strain curve help engineers during tensile testing?
- How is the method of joints used to determine internal forces in trusses?
- How do material properties affect structural stability, internal forces, and cost?
- How is the optimum speed limit determined for a roadway?
- How are different elements of infrastructure related?

Reflective

- Why is the value of beam deflection useful?
- Why is it crucial for designers and engineers to construct accurate free body diagrams of the parts and structures that they design?
- Why must designers and engineers calculate forces acting on bodies and structures?
- Why are stress and strain important factors to consider when designing?

Priority Standards

- 2.3 Analyze an engineering failure for the purpose of presenting an oral report which identifies causes, damage done, design failures, and other areas where the failure has impacted the environment or society.

Supporting Standards

- 3.2 Identify practical applications of each material category: composites, ceramics, polymers, and metals to engineered products and processes.

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Unit #5
Career Research

Essential Question
What kind of engineering interests you, what are your skills and strengths, what are your career goals, and what are the challenges and opportunities in your chosen field?

Unit Summary
Students explore different careers in engineering. Learning about the top engineering fields. They continue to explore future career opportunities by conducting a professional interview of a professional of their choice. Students continue their career exploration through investigating different pathways to higher education and determine their best course of action to make themselves good candidates for postsecondary education opportunities. They also continue their career exploration journey by examining the financial aspects of attending a postsecondary institution, along with the demand and salary of their chosen career.

Guiding Questions
Content
- What kind of engineering(STEM) field interests you?
- What is the job description of the top engineering fields?
- What is the educational path of selected engineering fields?

Process
- How does the cost of training compare to the salary of an engineering profession?
- How does a current engineer reflect on their profession?

Reflective
- Why pick one career path out of the STEM careers available?

Priority Standards

- 1.2 Discuss the differences between engineering disciplines and job functions.
- 1.3 Research the educational requirements to become an engineer.
- 1.4 Formulate an organized outline for a technical paper
- 1.5 Utilize materials from an assigned research topic to design and deliver a presentation.