Course Title:	Content Area:	Grade Level:	Credit (if applicable)
PLTW Principles of Engineering	CTE: Engineering and Technology	9-12	1 High School Credit 3 College Credits via UNH upon meeting UNH criteria

Course Description:

Principles of Engineering is a full-year course designed to be a high school student's second exposure to the PLTW Engineering program and is appropriate for students in grades 9-12. In Principles of Engineering, students explore a broad range of engineering disciplines, careers, and design and solve real-world engineering problems.

This course introduces students to engineering concepts that are applicable to a variety of engineering disciplines and empowers them to develop technical skills through the use of engineering tools such as 3-D modeling software, hands-on prototyping equipment, programming software, and robotics hardware to bring their solutions to life. Students apply the engineering design process to solve real-world problems across a breadth of engineering fields such as mechanical, robotics, infrastructure, environmental sustainability, and product design and development.

Using PLTW's activity-, project-, problem-based (APB) instructional approach, students advance from completing structured activities to solving open-ended projects and problems that provide opportunities to develop planning and technical documentation skills, as well as in-demand, transportable skills such as problem solving, critical thinking, collaboration, communication, and ethical reasoning. The last is particularly important as the course encourages students to consider the impacts of engineering decisions.

Through individual and collaborative team activities, projects, and problems, students create solutions to problems as they practice common engineering design and development protocols, such as experimental design, testing, project management, and peer review.

Aligned Core Resources:	Connection to the ***BPS Vision of the Graduate***
• PLTW Online *(some elements require PLTW login credentials)* • Course Outline - Principles of Engineering • Common Core State Standards for English Language Arts Anchor Standards • Common Core State Standards for Mathematics • Next Generation Science Standards • Standards for Technological and Engineering Literacy	**Meaningfully contribute to a global society:** Collaboration **Effectively communicate in a global society:** Communications and Technology Literacy **Demonstrate Academic Knowledge and Skills:** Critical Thinking and Problem Solving

Additional Course Information: *Knowledge/Skill Dependent courses/prerequisites*	Link to ***Completed Equity Audit***
Concurrent enrollment in grade appropriate math class.	Equity Curriculum Review - PLTW Principles of Engineering (2024-25)

Standard Matrix

See Standards Alignment - Principles of Engineering for alignment to:

- Common Core State Standards for English Language Standards *(Page 2)*
  - Anchor Standards: Research to Build and Present Knowledge
  - Writing: Text Types and Purposes
  - Reading Informational Text: Key Ideas and Details
- Common Core State Standards for Mathematics *(Page 7)*
  - Geometry: Visualization and Spatial Reasoning
  - Statistics and Probability: Interpreting Categorical and Quantitative Data
  - Statistics and Probability: Making Inferences and Justifying Conclusions
  - Number and Quantity: Quantities
- Next Generation Science Standards *(Page 12)*
  - Engineering Design: Developing Possible Solutions
  - Engineering Design: Evaluating Solutions
  - Engineering Design: Analyzing and Interpreting Data
  - Engineering Design: Optimizing the Design Solution
  - Engineering Design: Developing and Using Models
- Standards for Technological and Engineering Literacy *(Page 25)*

- Creativity and Innovation
- Communication and Collaboration
- Understanding and Applying Engineering Concepts
- Global Awareness in Engineering
- Technology and Engineering in Design
- Collaboration and Teamwork

Unit Links

Unit Title:	
Unit 0: Introduction to Product Design and Development	
Relevant Standards: Bold indicates priority	
Common Core State Standards for English Language Arts Common Core State Standards for Mathematics Next Generation Science Standards **Standards for Technological and Engineering Literacy**	
Essential Question(s):	**Enduring Understanding(s):**
0.1 - 1 How does a design team know what problem to solve? 0.1 - 2 Why is empathy an important skill in engineering design? 0.1 - 3 How do engineers communicate designs and solutions? 0.1 - 4 What is a decision matrix and why is it used? 0.2 - 1 What techniques do engineers use to visually present design ideas? 0.2 - 2 What advantages does Computer-Aided Design (CAD) provide over traditional paper and pencil design? 0.2 - 3 What advantages does paper and pencil design provide over CAD? 0.2 - 4 What would happen if engineers did not follow accepted dimensioning standards and guidelines, but instead, used their own individual dimensioning methods? 0.2 - 5 What are the differences between manufacturing processes? 0.3 - 1 What properties should be considered when evaluating material choice for a product? 0.3 - 2 What data should be collected in a testing process? 0.3 - 3 How is material testing data useful? 0.3 - 4 How does an engineer predict the performance and safety of a selected material? 0.3 - 5 What is the difference between the independent variable and the dependent variable in experimental design? 0.4 - 1 What are two possible ways that a team could come to a consensus in a disagreement over a solution to a problem? 0.4 - 2 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? 0.4 - 3 How can you design a product that meets the needs of a user?	• Engineers define problems by understanding user needs, identifying constraints, and analyzing real-world contexts. • Empathy is essential to engineering design because it helps create solutions that are meaningful, inclusive, and user-centered. • Effective communication through sketches, models, CAD, and standardized drawings ensures ideas are clearly shared and understood. • Decision-making tools, like decision matrices, help engineers evaluate design options objectively and collaboratively. • Both manual sketching and CAD play important roles in visualizing and refining design ideas, each offering unique advantages. • Following industry-standard drawing and dimensioning practices is critical to ensure consistency, accuracy, and manufacturability. • Engineers choose materials and processes based on performance data, testing results, and intended product use. • Teamwork, respectful collaboration, and shared decision-making are key to solving problems effectively and developing successful designs.
Demonstration of Learning:	**Pacing for Unit**
• Written documents, Formative and Summative Assessment, Hands on activities • Student teams take on the role of a product development team using the engineering design process to solve problems and create value for others.	16 Class Periods
Family Overview (link below)	**Integration of Technology:**

<table>
<tr><td>Family Overview - PLTW Principles of Engineering
Family Overview - PLTW Principles of Engineering (Spanish)</td><td>N/A</td></tr>
<tr><td>Unit-specific Vocabulary:</td><td>Aligned Unit Materials, Resources, and Technology (beyond core resources):</td></tr>
<tr><td><table><tr><td>Problem
Statement
Design Brief
Constraints
Criteria
Empathy
User-Centered
Design
Stakeholder
Sketching</td><td>Tolerance
Standardization
Decision Matrix
Prototype
Material
Properties
Stress/Strain
Projection
Dimensioning
CAD
(Computer-Aided
Design)</td><td>Testing
Manufacturing
Process
Consensus
Collaboration
Iteration
Communication
Feasibility
Orthographic
Technical Drawing</td></tr></table></td><td>N/A</td></tr>
<tr><td>Opportunities for Interdisciplinary Connections:</td><td>Anticipated misconceptions:</td></tr>
<tr><td>
Students apply math skills when using measurement, precision, and tolerances in sketching and CAD work, as well as when analyzing data from material testing and decision matrices.
The scientific method and experimentation are reinforced as students test materials, define variables, collect data, and evaluate results to predict material performance and safety.
Through technical and informational writing, students strengthen their ability to clearly document and communicate design ideas, write reports, and present solutions to both technical and non-technical audiences.
Exploring the ethics and impact of design allows students to consider real-world implications, such as accessibility, sustainability, and cultural relevance, connecting engineering decisions to broader social and historical contexts.
</td><td>
Students may think the problem is always clearly defined or given to them.
Students may believe empathy is only about "being nice" and not relevant to engineering.
Students may think rough sketches or personal styles are enough for communicating technical ideas.
Students may think CAD is always better than sketching.
Students may believe a decision matrix will always give the "correct" answer.
Students may assume the strongest material is always the best choice.
Students may think testing is just a final step to prove the design works.
Students may confuse independent and dependent variables, or think all variables are tested at once.
Students may believe consensus means everyone gets exactly what they want.
Students may assume the team leader should always make final decisions.
</td></tr>
<tr><td>Connections to Prior Units:</td><td>Connections to Future Units:</td></tr>
<tr><td>N/A</td><td>
The foundational skills in sketching, CAD, and dimensioning from Unit 0 are directly applied when students model and refine mechanical parts in Unit 1.
The problem-solving and iterative design process introduced in Unit 0 is critical as students develop and refine robotic systems in Unit 2.
The scientific testing process and data analysis techniques from Unit 0 are essential when evaluating energy systems and material performance in Unit 3.
The user-centered design principles from Unit 0 inform how students consider environmental and societal impacts when designing sustainable infrastructure in Unit 4.
</td></tr>
<tr><td colspan="2">Differentiation through Universal Design for Learning</td></tr>
</table>

UDL Indicator	Teacher Actions:

Learning Target 1: I can identify and define a clear problem based on user needs, constraints, and criteria.

- **Engagement and Representation:** Present students with an authentic, ill-defined problem rooted in a real-world context (perhaps a challenge facing their school or community). This inherently engages their interest and necessitates exploring user needs and constraints to even begin defining the problem.

Learning Target 3: I can communicate my design ideas using sketches, models, presentations, and technical documentation.

- **Engagement and Action & Expression:** Provide opportunities for students to communicate their design ideas for different purposes and to diverse audiences (e.g., peers for feedback, experts for critique, younger students to explain a concept). This emphasizes the importance of tailoring communication methods.

Learning Target 4: I can use a decision matrix to evaluate and select the best solution among alternatives.

- **Engagement and Representation:** Engage students in a group process to define the criteria for evaluating potential solutions, assigning weights based on importance. Then, collaboratively apply the decision matrix to the generated alternatives. This fosters ownership and understanding of the selection process.

Learning Target 5: I can use sketching, orthographic projections, and 3D models to present design ideas.

- **Action & Expression and Representation:** Provide structured instruction and practice for each representation method. Then, offer students choices in which methods they use to present different aspects of their design, allowing them to leverage their strengths and the most appropriate tool for the task.

Learning Target 6: I can explain and demonstrate the advantages of CAD software in the design process.

- **Action & Expression and Representation:** Provide direct access to CAD software and guide students through tasks that highlight its advantages (e.g., easy modification, precise dimensioning, generating multiple views) by comparing the time and effort required to do the same tasks manually.

Learning Target 7: I can describe when hand sketching is more effective than CAD in the design process.

- **Engagement and Action & Expression:** Engage students in rapid ideation challenges where quick sketching is essential for exploring numerous concepts quickly. Follow this with discussions comparing the efficiency of sketching versus CAD for early-stage design.

Learning Target 8: I can follow accepted dimensioning rules to ensure accurate communication of designs.

- **Action & Expression and Representation:** Provide students with examples of technical drawings (both correct and incorrect) from industry or practical scenarios and have them analyze and correct the dimensioning errors. This makes the rules more meaningful.

Learning Target 9: I can compare different manufacturing processes and choose the best method for a given product.

- **Engagement and Representation:** Have students examine existing products and research the likely manufacturing processes used. This allows them to connect design features to manufacturing constraints and advantages.

Learning Target 10: I can evaluate materials based on mechanical, thermal, and physical properties.

- **Engagement and Representation:** Engage students in either physical or virtual testing of different materials to observe and collect data on their properties. Analyzing this firsthand data makes the properties more tangible and relevant.

Learning Target 11: I can identify and collect accurate data during material or product testing.

- **Engagement and Action & Expression:** Guide students in designing their own simple experiments, emphasizing the identification of variables and the development of a clear data collection plan. Incorporate peer review of these plans before testing to ensure accuracy and validity.

Learning Target 12: I can use test data to make informed decisions about material selection and safety.

- **Engagement and Action & Expression:** Present students with design scenarios and provide them with sets of test data for different materials. Require them to justify their material selection based on the data and safety considerations.

Learning Target 13: I can use material properties and testing results to predict how a material will perform.

- **Engagement and Representation:** Use software or simulations that allow students to input material properties and predict performance under various conditions. Where possible, connect these predictions to real-world examples.

Learning Target 14: I can correctly identify variables in an experiment and control them to ensure valid results.

- **Engagement and Action & Expression:** Present students with simple, observable phenomena (the "mystery box"). Challenge them to design experiments to investigate the phenomena, explicitly requiring them to identify and justify their choice of independent, dependent, and control variables.

Learning Target 15: I can apply collaborative strategies to reach group consensus on a design solution.

- **Engagement and Action & Expression:** Assign specific roles within design teams and provide structured protocols for collaborative activities (e.g., brainstorming rules, decision-making frameworks). Follow up with individual and group reflections on the effectiveness of their collaboration.

Learning Target 16: I can explain why shared decision-making is essential in team engineering projects.

- **Engagement and Representation:** Examine real-world engineering projects where the presence or absence of effective shared decision-making significantly impacted the outcome (both positively and negatively). This provides compelling context for the importance of collaboration.

Supporting Multilingual/English Learners	
Related *CELP standards:*	**Learning Targets:**

CELP Standard	LT1	LT2	LT3	LT4	LT5	LT6	LT7	LT8	LT9	LT10	LT11	LT12	LT13	LT14	LT15	LT16	LT17
1. Construct meaning from oral presentations and literary and informational text	X	X				X	X		X	X	X	X	X	X		X	X
2. Participate in grade-appropriate oral and written exchanges of information, ideas, and analyses	X	X	X	X	X	X	X		X		X	X		X	X	X	X
3. Speak and write about grade-appropriate complex literary and informational texts and topics			X			X	X		X	X		X	X	X		X	X
4. Construct grade-appropriate oral and written claims and support them with reasoning and evidence	X			X		X	X		X	X		X	X	X		X	X
5. Conduct research and evaluate and communicate findings to answer questions or solve problems	X	X							X	X	X	X	X	X			X
6. Analyze and critique the arguments of others orally and in writing				X		X	X		X			X	X	X	X	X	X
7. Adapt language choices to purpose, task, and audience when speaking and writing			X		X	X	X	X	X	X	X	X	X				X
8. Determine the meaning of words and phrases in oral presentations and literary and informational text	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
9. Create clear and coherent grade-appropriate speech and text	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
10. Make accurate use of standard English to communicate in grade appropriate speech and writing	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Lesson Sequence	Learning Target	Success Criteria/ Assessment	Resources
1	I can identify and define a clear problem based on user needs, constraints, and criteria.	• I can conduct research or interviews to discover user needs. • I can write a clear and concise problem statement. • I can identify constraints (e.g., cost, materials, safety). • I can explain how the problem aligns with real-world needs.	
2	I can demonstrate empathy to understand user perspectives and needs in the design process.	• I can use user feedback to guide design decisions. • I can ask questions that reveal pain points or challenges. • I can consider diverse viewpoints and accessibility in my designs. • I can reflect user needs in my final solution.	
3	I can communicate my design ideas using sketches, models, presentations, and technical documentation.	• I can create annotated sketches or technical drawings. • I can present ideas clearly using visuals and spoken explanation.	

		• I can use appropriate vocabulary to describe engineering decisions. • I can collaborate and give constructive feedback.
4	I can use a decision matrix to evaluate and select the best solution among alternatives.	• I can identify multiple design solutions. • I can select appropriate criteria and assign weights. • I can score and compare solutions based on objective data. • I can justify the final decision using matrix results.
5	I can use sketching, orthographic projections, and 3D models to present design ideas.	• I can create freehand sketches with labels and dimensions. • I can draw isometric and orthographic views. • I can build 3D models to communicate form and function. • I can use visual tools to express design intent.
6	I can explain and demonstrate the advantages of CAD software in the design process.	• I can create a digital 3D model of a design. • I can modify and test designs quickly in CAD. • I can use CAD tools to measure and evaluate dimensions. • I can explain how CAD supports manufacturing and prototyping.
7	I can describe when hand sketching is more effective than CAD in the design process.	• I can quickly communicate initial ideas using sketches. • I can capture design thinking during brainstorming. • I can create rough visualizations without software tools. • I can combine sketches with written notes for ideation..
8	I can follow accepted dimensioning rules to ensure accurate communication of designs.	• I can apply ANSI or ISO standards when dimensioning. • I can dimension all critical features of a part clearly. • I can avoid redundant or conflicting dimensions. • I can explain how poor dimensioning leads to manufacturing errors.
9	I can compare different manufacturing processes and choose the best method for a given product.	• I can describe common manufacturing processes (e.g., casting, milling, 3D printing, injection molding). • I can match materials to compatible processes. • I can consider cost, complexity, and volume in decision-making. • I can justify process selection based on product requirements.
10	I can evaluate materials based on mechanical, thermal, and physical properties.	• I can compare tensile strength, elasticity, hardness, etc. • I can match material properties to function and environment. • I can consider cost, weight, durability, and recyclability. • I can choose materials based on performance data.
11	I can identify and collect accurate data during material or product testing.	• I can define independent, dependent, and control variables. • I can record force, stress, strain, deflection, etc. • I can use proper measurement tools and techniques. • I can organize data in charts, tables, or graphs.
12	I can use test data to make informed decisions about material selection and safety.	• I can analyze data to find trends and failure points. • I can compare materials based on test results. • I can identify safety margins and tolerances.

		• I can use results to improve future designs.
13	I can use material properties and testing results to predict how a material will perform.	• I can use stress-strain curves and material specs. • I can apply factors of safety in designs. • I can predict failure modes under real-world conditions. • I can make recommendations for safe use of materials.
14	I can correctly identify variables in an experiment and control them to ensure valid results.	• I can define and label independent, dependent, and control variables. • I can design fair tests that isolate variables. • I can explain how each variable affects results. • I can analyze how changing one variable influences the outcome.
15	I can apply collaborative strategies to reach group consensus on a design solution.	• I can use structured discussion or voting. • I can weigh evidence and consider all viewpoints. • I can compromise when necessary to move forward. • I can respect all team members' contributions.
16	I can explain why shared decision-making is essential in team engineering projects.	• I can describe how consensus leads to stronger, more inclusive designs. • I can identify the risks of a leader dominating the process. • I can encourage input from all team members. • I can reflect on how team dynamics affect project success.
17	I can use user feedback and data to design a product that effectively solves a real problem.	• I can identify user needs and constraints. • I can design a solution that fits those needs. • I can collect feedback and test with users. • I can improve the design based on real input.

Unit Title:	
Unit 1: Mechanical Design	
Relevant Standards: Bold indicates priority	
Common Core State Standards for English Language Arts Common Core State Standards for Mathematics Next Generation Science Standards **Standards for Technological and Engineering Literacy**	
Essential Question(s):	**Enduring Understanding(s):**
1.1 - 1 How do engineers quantify the mechanical advantage of a system? 1.1 - 2 How do engineers apply their knowledge of simple machines to solve problems? 1.1 - 3 How do engineers quantify energy, work, and power? 1.1 - 4 How do engineers apply their knowledge of energy, work, and power to solve problems? 1.2 - 1 How are mechanisms used to convert one type of motion to another? 1.2 - 2 How do engineers manipulate motion to solve design problems? 1.3 - 1 How can you apply your understanding of machines and mechanisms to solve an authentic problem?	Engineers apply principles of mechanical advantage, energy, work, power, and motion to design efficient systems that solve real-world problems. By understanding and manipulating simple machines and mechanisms, they can convert and control different types of motion to create innovative, functional, and efficient solutions.
Demonstration of Learning:	**Pacing for Unit**
• Written documents, Formative and Summative Assessment, Hands on activities • Students end the unit by working collaboratively and applying their knowledge to solve a real-world agricultural problem.	17 Class Periods
Family Overview (link below)	**Integration of Technology:**
Family Overview - PLTW Principles of Engineering Family Overview - PLTW Principles of Engineering (Spanish)	*N/A*
Unit-specific Vocabulary:	**Aligned Unit Materials, Resources, and Technology (beyond core resources):**
Simple Machines, Force, Work, Power, Energy, Input Force / Output Force, Effort / Load, Pulley, Lever, Inclined Plane Mechanical Advantage, Kinetic Energy, Potential Energy, Mechanical Efficiency, Torque, Velocity, Moment of Inertia, Screw, Wedge Friction, Load Distance, Effort Distance, Rotary Motion, Linear Motion, Gear Ratio, Linkage, Crank, Work-Energy Theorem, Wheel and Axle	N/A
Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions:**

• Energy, Work, and Power: Understanding how mechanical systems involve the transfer of energy, work done, and the relationship between force, distance, and energy directly ties to physics principles such as motion and thermodynamics. • Mechanical Advantage and Force Calculations: Calculating mechanical advantage, force, and efficiency involves applying algebraic equations and ratios, helping students practice mathematical problem-solving skills.	• A higher mechanical advantage always means a more efficient system. • Energy and work are the same thing.
Connections to Prior Units:	**Connections to Future Units:**
• The problem-solving and empathy learned in Unit 0 are foundational for students as they design mechanical systems in Unit 1. • The tools and strategies for defining problems, brainstorming solutions, and testing prototypes in Unit 0 are directly applied when considering mechanical advantage, efficiency, and system optimization in Unit 1. • Both units emphasize a user-centered approach, with Unit 0 focusing on the broader problem and context, while Unit 1 applies that understanding to design efficient mechanical systems that solve real-world problems.	• In Unit 2 (Application of Robotics), the principles of mechanical design are used to create and control robotic systems. • In Unit 3 (Energy in Action), students build on mechanical principles to explore energy conversion and optimization. • In Unit 4 (Designing Infrastructure and Developing Sustainability), mechanical design knowledge is applied to develop sustainable infrastructure that is efficient and energy-conscious.
Differentiation through *Universal Design for Learning*	
UDL Indicator	**Teacher Actions:**

Engagement

- Allow students to explore different mechanical design concepts (e.g., levers, pulleys, gears) through hands-on activities, simulations, or real-world case studies. Students can choose how they wish to engage with the material: through physical models, digital simulations, or problem-based learning activities.

Action & Expression

- Offer multiple ways to present complex mechanical design concepts, such as using visuals (diagrams, 3D models), providing interactive online tools (e.g., CAD software), and offering scaffolded explanations for technical terms. Provide glossaries and translated resources for English language learners (ELLs) to understand the specialized vocabulary used in mechanical design.

Supporting Multilingual/English Learners	
Related *CELP standards:*	**Learning Targets:**

CELP Standard	LT 1	LT 2	LT 3	LT 4	LT 5	LT 6	LT 7
1. Construct meaning from oral presentations and literary and informational text	X	X	X	X	X	X	X
2. Participate in grade-appropriate oral and written exchanges of information, ideas, and analyses	X	X	X	X	X	X	X
3. Speak and write about grade-appropriate complex literary and informational texts and topics	X	X	X	X	X	X	X
4. Construct grade-appropriate oral and written claims and support them with reasoning and evidence	X	X	X	X	X	X	X
5. Conduct research and evaluate and communicate findings to answer questions	X	X	X	X	X	X	X

or solve problems							
6. Analyze and critique the arguments of others orally and in writing	X	X	X	X	X	X	X
7. Adapt language choices to purpose, task, and audience when speaking and writing	X	X	X	X	X	X	X
8. Determine the meaning of words and phrases in oral presentations and literary and informational text	X	X	X	X	X	X	X
9. Create clear and coherent grade-appropriate speech and text	X	X	X	X	X	X	X
10. Make accurate use of standard English to communicate in grade appropriate speech and writing	X	X	X	X	X	X	X

Lesson Sequence	**Learning Target**	**Success Criteria/ Assessment**	**Resources**
1	I can calculate ideal and actual mechanical advantage using input and output forces or distances.	• I can correctly calculate IMA using distance ratios • I can correctly calculate AMA using force measurements • I can compare and explain differences between IMA and AMA • I can identify real-world factors (like friction) that affect mechanical advantage	
2	I can identify and apply simple machines to design systems that reduce effort or optimize mechanical advantage.	• I can identify the six types of simple machines in real mechanisms • I can choose appropriate simple machines to solve a problem • I can explain how a system of simple machines reduces force or changes motion • I can create or analyze a design using two or more simple machines	
3	I can calculate work, energy, and power using standard formulas and appropriate units.	• I can use formulas to calculate work ($W = F \times d$), power ($P = W/t$), and energy • I can use correct units (joules, watts, newtons, etc.) in calculations • I can create labeled diagrams showing force, distance, and energy transfer • I can solve problems involving energy efficiency	
4	I can apply energy principles to analyze and improve the performance of mechanical systems.	• I can analyze a system for energy input, output, and losses • I can calculate power requirements for a machine or system • I can recommend ways to improve system efficiency • I can justify design choices based on energy and power calculations	
5	I can explain how different mechanisms (cams, gears, linkages) convert one type of motion into another.	• I can describe different types of motion (linear, rotary, reciprocating, oscillating) • I can identify mechanisms (like cams, cranks, rack and pinion) and explain their motion conversion • I can illustrate input/output motion using diagrams • I can match real-world devices to the appropriate motion transformation	
6	I can design systems that manipulate speed, torque, or direction of motion using mechanical components.	• I can calculate gear ratios, torque, and speed changes in mechanisms	

		• I can modify a mechanism to meet design criteria (e.g., increase torque or speed) • I can build and test a prototype that controls or changes motion • I can explain design choices using mechanical reasoning
7	I can use the engineering design process and my knowledge of machines and mechanisms to develop a functional solution to a real-world problem.	• I can identify a real-world problem that can be addressed with mechanical systems • I can use the engineering design process to brainstorm, design, build, and test a solution • I can integrate knowledge of machines and mechanisms into my design • I can evaluate and refine the solution based on performance data

Unit Title:

Unit 2: Application of Robotics

Relevant Standards: Bold indicates priority

Common Core State Standards for English Language Arts
Common Core State Standards for Mathematics
Next Generation Science Standards
Standards for Technological and Engineering Literacy

Essential Question(s):

2.1 - 1 What characteristics define a robot?
2.2 - 1 What practices do programmers use to write effective code?
2.2 - 2 How do engineers use sensors to solve design problems?
2.3 - 1 What is artificial intelligence, and how do engineers use it to solve problems?
2.3 - 2 What are some of the ethical implications of artificial intelligence?
2.4 - 1 How can you apply your understanding of mechanics and programming to solve a design problem?

Enduring Understanding(s):

Engineers integrate mechanical systems, programming, and sensors to design intelligent, responsive robots that solve real-world problems. By understanding how robots function, how to write efficient code, and how to apply artificial intelligence ethically and effectively, students are empowered to create solutions that interact with the physical world in meaningful and innovative ways.

Demonstration of Learning:

- Written documents, Formative and Summative Assessment, Hands on activities

Pacing for Unit

18 Class Periods

Family Overview (link below)

[Family Overview - PLTW Principles of Engineering](#)
[Family Overview - PLTW Principles of Engineering (Spanish)](#)

Integration of Technology:

N/A

Unit-specific Vocabulary:

Automation Actuator Algorithm Artificial Intelligence (AI) Sensor Servo Motor Mechanical Engineering Programming Language	Feedback Loop End Effector Computer Vision Machine Learning Data Processing Binary Code Prototyping Simulation Microcontroller Control System	Torque Kinematics Feedback Mechanism Ethical Engineering Precision Engineering Human-Computer Interaction Cognitive Computing

Aligned Unit Materials, Resources, and Technology (beyond core resources):

N/A

Opportunities for Interdisciplinary Connections:

- Students can apply algebra and geometry concepts in programming logic, control systems, and sensor data processing (e.g., using equations to program motion paths or understand angular displacement in robotics).

Anticipated misconceptions:

- Robots are only machines that look human.
- AI is a single, all-knowing system.
- Robots are always autonomous and do not need human control.
- Programming is only about writing code.
- All AI systems are the same.

• Understanding of mechanics and physical forces (e.g., Newton's laws, force, and motion) can be applied to how robots interact with their environments, especially in designing robotic arms or autonomous vehicles. • Exploring the societal and ethical implications of artificial intelligence, especially as it relates to job automation, privacy, and safety.	
Connections to Prior Units:	**Connections to Future Units:**
• Unit 2 builds on the product development process from Unit 0 by applying the design, prototyping, and testing concepts to robotics. • Knowledge of user needs and concept sketches in Unit 0 are used to design functional robots in Unit 2. • Unit 2 applies mechanical design principles from Unit 1 (e.g., force, motion, actuators) to build robotic systems. • Students use mechanical design knowledge from Unit 1 to create the physical structures and movements of robots (e.g., joints, frames, gears).	• Robotics systems in Unit 2 require energy management for powering actuators, sensors, and motors, which connects to energy principles explored in Unit 3. • Robotics from Unit 2 can be applied to sustainable infrastructure projects, improving efficiency and reducing waste in sectors like construction and agriculture. • Robotics plays a role in sustainable design by automating tasks and optimizing resource usage, which ties into the sustainability focus of Unit 4.

Differentiation through *Universal Design for Learning*

UDL Indicator	**Teacher Actions:**

Representation
- Provide a variety of learning materials such as videos, interactive simulations, diagrams, and hands-on activities (e.g., robot building, coding exercises) to engage different types of learners. Use accessible language and scaffolding techniques when explaining complex concepts like AI and programming.

Engagement
- Allow students to choose a specific robot design problem or coding project based on their interests, encouraging creativity and autonomy. Provide real-world examples of how robotics and AI solve problems in various industries to emphasize relevance.

Action & Expression
- Encourage students to demonstrate their understanding of concepts through a variety of formats: presentations, videos, written reports, or building prototypes. For example, students could present a design proposal for a robot using diagrams and code, and explain its function to the class.

Supporting Multilingual/English Learners

Related *CELP standards:*	**Learning Targets:**

CELP Standard	LT 1	LT 2	LT 3	LT 4	LT 5	LT 6
1. Construct meaning from oral presentations and literary and informational text	X	X	X	X	X	X
2. Participate in grade-appropriate oral and written exchanges of information, ideas, and analyses	X	X	X	X	X	X
3. Speak and write about grade-appropriate complex literary and informational texts and topics	X	X	X	X	X	X
4. Construct grade-appropriate oral and written claims and support them with reasoning and evidence	X	X	X	X	X	X
5. Conduct research and evaluate and communicate findings to answer questions or solve problems	X	X	X	X	X	X
6. Analyze and critique the arguments of others orally and in writing		X		X	X	
7. Adapt language choices to purpose, task, and	X	X	X	X	X	X

audience when speaking and writing						
8. Determine the meaning of words and phrases in oral presentations and literary and informational text	X	X	X	X	X	X
9. Create clear and coherent grade-appropriate speech and text	X	X	X	X	X	X
10. Make accurate use of standard English to communicate in grade appropriate speech and writing	X	X	X	X	X	X

Lesson Sequence	**Learning Target**	**Success Criteria/ Assessment**	**Resources**
1	I can explain the key characteristics that define a robot, including its ability to perform tasks autonomously or semi-autonomously through sensors, actuators, and programming.	• I can identify at least three characteristics that define a robot (e.g., sensors, actuators, programming). • I can provide an example of a robot and explain how it fits the definition based on these characteristics. • I can distinguish between robots and other automated machines.	
2	I can describe best practices for writing effective code, including problem-solving techniques, debugging, and organizing code for efficiency and clarity.	• I can explain the steps of the programming process (e.g., planning, writing, testing, debugging). • I can identify common practices like using comments, breaking down problems into smaller steps, and modularizing code. • I can demonstrate debugging skills by identifying and fixing an error in a simple program.	
3	I can explain how engineers use different types of sensors (e.g., temperature, pressure, motion) to collect data and solve design challenges.	• I can describe at least two types of sensors and their functions in a robotic system or engineering design. • I can explain how sensor data informs decision-making in engineering projects (e.g., adjusting a robot's movement based on distance or obstacles). • I can demonstrate how to use a sensor in a simple engineering project to collect and apply data to solve a problem.	
4	I can define artificial intelligence and describe how engineers apply AI to solve real-world problems (e.g., automation, predictive modeling, autonomous vehicles).	• I can provide a clear definition of AI and distinguish it from basic programming or automation. • I can explain at least two ways engineers use AI to solve problems (e.g., object recognition in autonomous robots). I can apply AI concepts to a practical scenario, such as designing an AI-driven robot or system.	
5	I can identify and analyze the ethical implications of artificial intelligence, including issues like privacy, job displacement, and bias.	• I can list at least three ethical concerns related to AI (e.g., privacy violations, biased algorithms). • I can discuss real-world examples where AI raised ethical questions. • I can engage in a discussion or debate on the ethical considerations of implementing AI in society, presenting both sides of the argument.	
6	I can integrate principles of mechanics (e.g., force, motion) and programming to develop a solution to a design problem, such as creating a functional prototype.	• I can apply mechanical principles (e.g., using pulleys, gears, levers) to design and build a working mechanism. • I can write and test code to control a system or prototype (e.g., programming a robotic arm to move).	

		• I can troubleshoot and improve the functionality of my design by refining both the mechanical structure and the code.

<table>
<tr><th colspan="2">Unit Title:</th></tr>
<tr><td colspan="2">Unit 3: Energy in Action</td></tr>
<tr><th colspan="2">Relevant Standards: Bold indicates priority</th></tr>
<tr><td colspan="2">Common Core State Standards for English Language Arts
Common Core State Standards for Mathematics
Next Generation Science Standards
Standards for Technological and Engineering Literacy</td></tr>
<tr><th>Essential Question(s):</th><th>Enduring Understanding(s):</th></tr>
<tr><td>3.1 - 1 How do you differentiate between circuit types?
3.1 - 2 How do you model electrical circuits?
3.1 - 3 How do you test circuit parameters?
3.1 - 4 What are the mathematical relationships between circuit parameters?
3.1 - 5 Why are Kirchhoff's Laws important to engineers and designers of electrical circuits?
3.2 - 1 What impact does fluid power have on our everyday lives?
3.2 - 2 What devices or systems might be improved with the use of fluid power?
3.2 - 3 What are the similarities and differences of mechanical advantage in simple machines?
3.2 - 4 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?
3.3 - 1 How do we graph and analyze motion?
3.3 - 2 What equations govern how objects move?
3.3 - 3 How do we predict where projectiles will land?</td><td>The behavior of electrical circuits can be understood and predicted through mathematical relationships like Ohm's Law and Kirchhoff's Laws. These laws are essential for designing and analyzing electrical systems.
Kirchhoff's Laws are critical for solving complex electrical circuits, ensuring the conservation of current and voltage. They are fundamental for engineers when working with circuits that have multiple components.
Fluid power systems (hydraulic and pneumatic) are essential in industries and everyday devices, offering powerful solutions for tasks requiring force multiplication and control. Understanding fluid dynamics helps engineers design efficient systems.
Simple machines, like levers and pulleys, use mechanical advantage to reduce the amount of force needed to accomplish tasks. Understanding this principle helps engineers design systems that maximize efficiency.
Fluid dynamics principles, such as Pascal's Law and Bernoulli's Principle, are foundational for designing and optimizing hydraulic and pneumatic systems used in a wide range of applications.
The motion of objects is governed by physical laws that can be described and predicted with mathematical equations. Understanding these laws is key to designing systems involving movement, like in mechanical and transportation engineering.
The behavior of projectiles can be predicted using kinematic equations, which account for both horizontal and vertical motion. Engineers use this to design systems that require trajectory planning, such as in robotics or aerospace.</td></tr>
<tr><th>Demonstration of Learning:</th><th>Pacing for Unit</th></tr>
<tr><td>Written documents, Formative and Summative Assessment, Hands on activities</td><td>17 Class Periods</td></tr>
<tr><th>Family Overview (link below)</th><th>Integration of Technology:</th></tr>
<tr><td>Family Overview - PLTW Principles of Engineering
Family Overview - PLTW Principles of Engineering (Spanish)</td><td>N/A</td></tr>
<tr><th>Unit-specific Vocabulary:</th><th>Aligned Unit Materials, Resources, and Technology</th></tr>
</table>

<table>
<tr><th></th><th>(beyond core resources):</th></tr>
<tr><td><table><tr><td>Voltage
Current
Resistance
Ohm’s Law
Circuit
Series Circuit
Parallel Circuit
Power (in circuits)
Capacitance
Pascal’s Law</td><td>Inductance
Kirchhoff’s Current Law (KCL)
Kirchhoff’s Voltage Law (KVL)
Fluid Power
Hydraulic Systems
Pneumatic Systems
Bernoulli’s Principle</td><td>Mechanical Advantage
Simple Machines
Force
Velocity
Acceleration
Projectile Motion
Kinematics
Work-Energy Theorem</td></tr></table></td><td>N/A</td></tr>
<tr><th>Opportunities for Interdisciplinary Connections:</th><th>Anticipated misconceptions:</th></tr>
<tr><td>Understanding the mathematical relationships in circuits (Ohm’s Law, Kirchhoff’s Laws) requires algebra, and graphing motion involves geometric concepts (such as the trajectory of projectiles).
Fluid power systems rely on principles from fluid dynamics, such as Pascal’s Law and Bernoulli’s Principle, while motion analysis draws on kinematics and forces.</td><td>In a series circuit, the current is different across each component.
Hydraulic and pneumatic systems work the same way because both use pressure.
The mechanical advantage of a machine is always greater than 1.
Projectiles move in a straight line when thrown.
Resistance always increases with temperature in a circuit.</td></tr>
<tr><th>Connections to Prior Units:</th><th>Connections to Future Units:</th></tr>
<tr><td>Unit 3 builds on the design process from Unit 0 by applying energy principles to create functional and efficient products.
Knowledge from Unit 0 about prototyping and iterative testing informs how energy-efficient systems are tested and improved in Unit 3.
Energy principles in Unit 3 complement mechanical design concepts from Unit 1, where energy is transferred and converted within mechanical systems.
Understanding mechanical components, such as gears, pulleys, and levers from Unit 1, is essential for analyzing energy flow and efficiency in systems like engines or machines in Unit 3.
Unit 3 connects to Unit 2 as robotics systems often rely on energy sources, including electrical power and mechanical energy, to function.
Understanding how energy is used in robotics, such as motors and sensors, from Unit 2 ties directly into the energy analysis and optimization discussed in Unit 3.</td><td>In Unit 3, energy principles are directly applied to energy-efficient systems, which ties into the sustainability focus of Unit 4. Students will learn how to design sustainable infrastructure that uses energy more effectively and reduces waste.
Energy systems discussed in Unit 3, such as renewable energy sources, will be foundational for creating sustainable infrastructure in Unit 4.</td></tr>
<tr><th colspan="2">Differentiation through <u>Universal Design for Learning</u></th></tr>
<tr><th>UDL Indicator</th><th>Teacher Actions:</th></tr>
<tr><td colspan="2">Representation
Use diagrams, circuit simulations, and interactive models to visually represent circuit behavior. Include verbal explanations of the key concepts while encouraging hands-on experiments to demonstrate circuit testing and fluid power systems.
Engagement</td></tr>
</table>

- Provide students with choices in project topics, such as designing a fluid power system or creating a working electrical circuit. Relate activities to real-world applications like hydraulics in construction or electrical circuits in electronics.

Action & Expression

- Allow students to present their findings in various formats, such as diagrams, written reports, or presentations. Encourage group work where students can build a physical prototype and explain its function in front of the class.

Supporting Multilingual/English Learners

Related *CELP standards:*	**Learning Targets:**

CELP Standard	LT 1	LT 2	LT 3	LT 4	LT 5	LT 6	LT 7	LT 8	LT 9	LT 10	LT 11	LT 12
1. Construct meaning from oral presentations and literary and informational text	X	X	X	X	X	X	X	X	X	X	X	X
2. Participate in grade-appropriate oral and written exchanges of information, ideas, and analyses	X	X	X	X	X	X	X	X	X	X	X	X
3. Speak and write about grade-appropriate complex literary and informational texts and topics	X	X	X	X	X	X	X	X	X	X	X	X
4. Construct grade-appropriate oral and written claims and support them with reasoning and evidence	X	X	X	X	X	X	X	X	X	X	X	X
5. Conduct research and evaluate and communicate findings to answer questions or solve problems	X	X	X	X	X	X	X	X	X	X	X	X
6. Analyze and critique the arguments of others orally and in writing	X		X	X	X		X	X	X	X	X	X
7. Adapt language choices to purpose, task, and audience when speaking and writing	X	X	X	X	X	X	X	X	X	X	X	X
8. Determine the meaning of words and phrases in oral presentations and literary and informational text	X	X	X	X	X	X	X	X	X	X	X	X
9. Create clear and coherent grade-appropriate speech and text	X	X	X	X	X	X	X	X	X	X	X	X
10. Make accurate use of standard English to communicate in grade appropriate speech and writing	X	X	X	X	X	X	X	X	X	X	X	X

Lesson Sequence	**Learning Target**	**Success Criteria/ Assessment**	**Resources**
1	I can identify and explain the differences between series and parallel circuits based on their electrical properties and behavior.	• I can distinguish between series and parallel circuits. I can explain how current and voltage behave differently in each type of circuit.	
2	I can create accurate diagrams of electrical circuits using standard symbols and explain the components and their connections.	• I can draw a circuit diagram that follows proper electrical symbols. I can explain the function of each component in a circuit diagram.	
3	I can measure voltage, current, and resistance in a circuit and analyze the results.	• I can use a multimeter to measure voltage, current, and resistance. I can interpret the measurements to identify problems or optimize circuit performance.	
4	I can apply Ohm's Law and other mathematical equations to calculate and	• I can calculate voltage, current, and resistance in a circuit using Ohm's Law.	

	analyze circuit parameters.	• I can apply Kirchhoff's Laws to solve for unknown circuit parameters.
5	I can explain the importance of Kirchhoff's Current and Voltage Laws in analyzing complex circuits.	• I can apply Kirchhoff's Current Law (KCL) and Kirchhoff's Voltage Law (KVL) to solve circuit problems. • I can explain how these laws ensure that circuits are designed correctly and safely.
6	I can identify how fluid power systems are used in everyday devices and industries.	• I can list at least three devices or systems that use fluid power. • I can explain the benefits of fluid power in industrial application
7	I can describe how fluid power can improve the performance and efficiency of mechanical systems.	• I can identify a system or device that can be improved by fluid power. • I can explain how the use of fluid power improves system performance.
8	I can compare and contrast the mechanical advantage in simple machines (e.g., levers, pulleys).	• I can define mechanical advantage and explain how it works in different simple machines. • I can calculate the mechanical advantage in various simple machine systems.
9	I can explain the role of fundamental fluid dynamics principles (Pascal's Law, Bernoulli's Principle) in fluid power systems.	• I can explain Pascal's Law and Bernoulli's Principle in the context of fluid power systems. • I can describe how these principles are used to design efficient fluid power systems.
10	I can graph and interpret the motion of objects, including displacement, velocity, and acceleration.	• I can create motion graphs (e.g., position vs. time, velocity vs. time). • I can analyze the graphs to describe the object's motion.
11	I can apply kinematic equations to solve problems involving the motion of objects.	• I can use the kinematic equations to calculate displacement, velocity, and acceleration. • I can explain how these equations relate to the real-world motion of objects.
12	I can apply projectile motion equations to predict the landing location of a projectile.	• I can use the horizontal and vertical motion equations to solve projectile motion problems. • I can predict the range of a projectile given its initial velocity and angle of launch.

Unit Title:	
Unit 4: Designing Infrastructure and Developing Sustainability	
Relevant Standards: Bold indicates priority	
Common Core State Standards for English Language Arts Common Core State Standards for Mathematics Next Generation Science Standards **Standards for Technological and Engineering Literacy**	
Essential Question(s):	**Enduring Understanding(s):**
4.1 - 1 What factors impact beam deflection? 4.1 - 2 Why is the value of beam deflection useful? 4.1 - 3 What are the properties of structural members and why are they useful? 4.1 - 4 What is a centroid and how is it applied in structural members? 4.1 - 5 Why is it crucial for designers and engineers to construct accurate free body diagrams of the parts and structures that they design? 4.1 - 6 Why must designers and engineers calculate forces acting on bodies and structures? 4.1 - 7 What are the differences between stress and strain? 4.1 - 8 Why are stress and strain important factors to consider when designing? 4.1 - 9 How does the stress-strain curve help engineers during tensile testing? 4.1 - 7 What is a moment and how does it help solve problems in static structures? 4.1 - 8 When solving truss forces, why is it important to know that the structure is statically determinate? 4.1 - 9 How is the method of joints used to determine internal forces in trusses? 4.1 - 10 How do material properties affect structural stability, internal forces, and cost? 4.2 - 1 What are renewable and nonrenewable resources and how do humans use them? 4.2 - 2 In what innovative ways could the efficiency of electricity production using solar cells be maximized throughout the day? 4.3 - 1 What factors affect the rate of flow on a roadway? 4.3 - 2 How is the optimum speed limit determined for a roadway? 4.3 - 3 In your opinion, what type of intersection is prone to the most accidents? What can be done to maximize safety at this type of intersection? 4.4 - 1 What role does creativity have in the engineering design process? 4.4 - 2 What do engineers do to clearly document and communicate their work? Why is this important? 4.4 - 3 How are different elements of infrastructure related?	• Beam deflection is influenced by material properties, geometry, and load distribution, and understanding these factors is essential for designing stable and functional structures. • Beam deflection is a critical parameter that ensures structures perform without excessive bending or failure, aiding in the optimization of design for strength and safety. • The properties of structural members, such as strength, elasticity, and stiffness, determine their performance under load and are essential for safe and efficient design. • The centroid is essential for structural analysis, helping determine the distribution of forces and moments, enabling more efficient and balanced design. • Free body diagrams are vital tools for understanding and calculating the forces and moments acting on structures, ensuring accurate and reliable design analysis. • Calculating forces is fundamental to structural design, allowing engineers to ensure stability and prevent failure under expected load conditions. • Stress and strain describe how materials respond to forces, and understanding their relationship is key to selecting appropriate materials and ensuring structural integrity. • The stress-strain curve aids in understanding material behavior under tension, helping engineers choose materials that are best suited for specific structural requirements. • Creativity is integral to the engineering design process, enabling innovative solutions to complex problems and contributing to the development of efficient, sustainable designs. • Different infrastructure systems are interrelated, requiring an integrated approach to design to ensure that transportation, energy, and other systems function together effectively.
Demonstration of Learning:	**Pacing for Unit**

<table>
<tr><td>

- Written documents, Formative and Summative Assessment, Hands on activities
- Students work collaboratively in teams to develop solutions to structural design problems, sustainable approaches, and transportation design needs that have a lasting impact on local and global communities.
- Students conclude their career exploration by examining the future of different careers and how they will be affected by the adoption of artificial intelligence.

</td><td>20 Class Periods</td></tr>
<tr><th>Family Overview (link below)</th><th>Integration of Technology:</th></tr>
<tr><td>Family Overview - PLTW Principles of Engineering
Family Overview - PLTW Principles of Engineering (Spanish)</td><td>N/A</td></tr>
<tr><th>Unit-specific Vocabulary:</th><th>Aligned Unit Materials, Resources, and Technology (beyond core resources):</th></tr>
<tr><td>
<table>
<tr><td>Reaction Force
Stress
Strain
Tensile Testing
Stress-Strain Curve
Elasticity
Modulus of Elasticity
Free Body Diagram (FBD)
Force</td><td>Moment
Truss
Statically Determinate
Method of Joints
Internal Forces
Material Properties
Structural Member
Centroid</td><td>Shear Force
Bending Moment
Axial Force
Plastic Deformation
Ultimate Strength
Elastic Deformation
Beam Deflection
Load Distribution</td></tr>
</table>
</td><td>N/A</td></tr>
<tr><th>Opportunities for Interdisciplinary Connections:</th><th>Anticipated misconceptions:</th></tr>
<tr><td>

- The principles of force, moment, and stress/strain tie directly into basic mechanics. Students will apply these concepts when analyzing and solving problems in both static and dynamic systems.
- Calculating beam deflection, moments, and force distributions involves algebra and calculus to solve equations that model physical systems.
- Concepts from structural analysis in Unit 4 can be connected to renewable energy systems, particularly in the design and analysis of structures like wind turbines and solar panels.

</td><td>

- Beam deflection is always proportional to the load applied.
- Stress and strain are the same thing.
If a structure doesn't fail immediately under a load, it's safe.
Free body diagrams are only for static systems.
Material properties are the same for all applications.

</td></tr>
<tr><th>Connections to Prior Units:</th><th>Connections to Future Units:</th></tr>
<tr><td>

- Unit 4 builds on the product design process from Unit 0, applying it to the design of sustainable infrastructure and energy-efficient systems, emphasizing real-world application and iterative testing.
- The principles of mechanical design from Unit 1 are used to ensure the structural integrity and functionality of infrastructure systems in Unit 4, including material selection and load distribution.
- Robotics concepts from Unit 2 connect to infrastructure design in Unit 4, where automation

</td><td>N/A</td></tr>
</table>

and robotic systems could be integrated into the construction and maintenance of infrastructure for increased efficiency. • Unit 4 extends the energy principles explored in Unit 3, focusing on renewable energy sources and sustainable design practices, such as wind, solar, and energy-efficient building methods.	

Differentiation through *Universal Design for Learning*

UDL Indicator	**Teacher Actions:**

Representation

- Use diagrams and interactive models to demonstrate how forces act on beams and structures. Encourage students to use physical models or simulations to test different loads and observe beam deflection.

Engagement

- Provide students with project options that connect to real-world applications, such as designing a bridge or analyzing the forces on a building. This helps engage students by showing the relevance of structural analysis to everyday life.

Action & Expression

- Allow students to express their understanding through various formats, such as written reports, presentations, or physical prototypes. This supports different learning styles and helps students engage with the material in diverse ways.

Supporting Multilingual/English Learners

Related *CELP standards:*	**Learning Targets:**

CELP Standard	LT 1	LT 2	LT 3	LT 4	LT 5	LT 6	LT 7	LT 8	LT 9	LT 10	LT 11	LT 12
1. Construct meaning from oral presentations and literary and informational text	X	X	X	X	X	X	X	X	X	X	X	X
2. Participate in grade-appropriate oral and written exchanges of information, ideas, and analyses	X	X	X	X	X	X	X	X	X	X	X	X
3. Speak and write about grade-appropriate complex literary and informational texts and topics	X	X	X	X	X	X	X	X	X	X	X	X
4. Construct grade-appropriate oral and written claims and support them with reasoning and evidence	X	X	X	X	X	X	X	X	X	X	X	X
5. Conduct research and evaluate and communicate findings to answer questions or solve problems	X	X	X	X	X	X	X	X	X	X	X	X
6. Analyze and critique the arguments of others orally and in writing	X	X	X	X	X	X	X	X	X	X	X	X
7. Adapt language choices to purpose, task, and audience when speaking and writing	X	X	X	X	X	X	X	X	X	X	X	X
8. Determine the meaning of words and phrases in oral presentations and literary and informational text	X	X	X	X	X	X	X	X	X	X	X	X
9. Create clear and coherent grade-appropriate speech and text	X	X	X	X	X	X	X	X	X	X	X	X
10. Make accurate use of standard English to communicate in grade appropriate speech and writing	X	X	X	X	X	X	X	X	X	X	X	X

Lesson Sequence	**Learning Target**	**Success Criteria/ Assessment**	**Resources**

1	I can identify and explain the factors that influence beam deflection, including material properties, load distribution, and beam geometry.	• I can list factors affecting beam deflection and explain their impact using examples.
2	I can explain why beam deflection is a critical parameter in structural design.	• I can discuss how deflection affects the performance and safety of structures.
3	I can identify and explain the material properties (strength, stiffness, elasticity) that influence the performance of structural members.	• I can describe how material properties affect design decisions in structural engineering.
4	I can explain what a centroid is and how it is used in calculating moments and load distributions.	• I can calculate the centroid of simple shapes and apply it to structural analysis.
5	I can describe the purpose and process of creating free body diagrams for structural analysis.	• I can create a free body diagram for a simple structure and use it to solve for unknown forces.
6	I can explain the importance of calculating forces in the design and safety of structures.	• I can calculate the forces acting on a structure using known loads and support conditions.
7	I can explain the difference between stress and strain and describe how they are related.	• I can apply the concepts of stress and strain to real-world materials and structural problems.
8	I can explain why considering stress and strain is crucial for material selection and ensuring structural integrity.	• I can use the concepts of stress and strain to evaluate whether a material is suitable for a specific application.
9	I can interpret the stress-strain curve and explain how it helps engineers assess material performance during tensile testing.	• I can identify key points on a stress-strain curve (yield strength, ultimate strength) and explain their significance.
10	I can define a moment and explain its role in solving problems involving static structures.	• I can calculate moments acting on a structure and use them to determine the stability of the system.
11	I can explain the concept of statically determinate structures and why it is important for solving truss forces.	• I can identify whether a truss is statically determinate and explain how this impacts the solution process.
12	I can analyze how different material properties (e.g., strength, elasticity) affect structural stability and cost.	• I can select appropriate materials for a structure based on their properties and the requirements of the design.