**CURRICULUM MAP**

**Course/Subject:** Design and Applied Engineering  
**Grade:** 9th – 12th  
**Month:** September – October (Section/Unit – What are Design and Engineering?)

### Enduring Understanding

- Technology is not an object or artifact but a process by which we solve problems.
- Technological literacy is the ability to use, assess and manage technology around us.
- Each area of technology has a set of characteristics that separates it from others; however, many areas overlap in order to meet human needs and wants.
- Engineers solve problems to better humanity
- Products have both form and function

### Essential Questions

- How does Technology effect/affect my life?
- How can solving a problem positively or negatively affect society or the environment?
- What does an engineer do?
- How are products designed and developed?

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<th>Standards</th>
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</table>
| 3.4.10.A1. Illustrate how the development of technologies is often driven by profit and an economic market. | What is Technology?  
- The process of human beings using resources to solve problems to satisfy needs and wants | - Identify technological artifacts and define technology | Written test / Quiz |
| 3.4.12.A1. Compare and contrast the rate of technological development over time. | Trade-offs and Outcomes  
- What is a trade-off  
- The 4 outcomes | - Recognize the pro’s and con’s of a technological item  
- Identify the four possible outcomes of a given technological item | |
| 3.4.10.A2. Interpret how systems thinking applies logic and creativity with appropriate comprises in complex real-life problems. | What is Engineering?  
- Engineering is the practical application of science and math to solve problems  
- What does an Engineer do? | - Define engineering and list different types of engineers | |
| 3.4.10.A3. Examine how technology transfer occurs when a new user applies an existing innovation developed for one purpose in a | | | |
3.4.12.A3. Demonstrate how technological progress promotes the advancement of science, technology, engineering and mathematics (STEM).

3.4.10.B1. Compare and contrast how the use of technology involves weighing the trade-offs between the positive and negative effects.


3.4.10.B2. Demonstrate how humans devise technologies to reduce the negative consequences of other technologies.

3.4.12.B2. Illustrate how, with the aid of technology, various aspects of the environment can be monitored to provide information for decision making.

3.4.10.B4. Recognize that technological development has been evolutionary, the result of a series of refinements to a basic invention.

3.4.10.C1. Apply the components of the technological design process.

3.4.10.C2. Analyze a prototype and/or create a working model to test a design concept by making actual observations and necessary adjustments.

3.4.12.C2. Apply the concept that engineering design is influenced by personal characteristics, such as

<table>
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<tr>
<th>The Design Loop</th>
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<tr>
<td>1. Define the Problem</td>
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<td>2. Research the Problem</td>
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<td>3. Brainstorm</td>
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<td>4. Choose the Best Solution</td>
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<td>5. Create a Prototype</td>
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<td>6. Test and Evaluate</td>
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<td>7. Redesign</td>
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<tr>
<th>Product Design (1st Half)</th>
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<tbody>
<tr>
<td>- Criteria</td>
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<td>- Constraints</td>
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<td>- Product Research</td>
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<td>- Market Survey</td>
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<td>- Mass Markets</td>
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<td>- Niche Markets</td>
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<tr>
<th>Product Design (2nd Half)</th>
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<tr>
<td>- Form and Function</td>
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<tr>
<td>- Modeling</td>
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<tr>
<td>- Redesign based on Manufacturing</td>
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<tr>
<td>- Project Presentation</td>
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</table>

- List the steps of the design loop
- Follow the steps of the design loop to create a solution to a given problem

- Create criteria and constraints
- Apply a design to identified criteria and constraints
- Create or utilize a market survey to determine the desire for a product

- Safely utilize the tools and materials in the lab to create a model or prototype
- Create a model of a solution from a chosen design
- Incorporate aesthetics into the functional solution
- Utilize knowledge of manufacturing processes to redesign product for safety and cost
- Present a solution to problem using appropriate methods

Written Test

Documentation packet
Grading Rubric
creativity, resourcefulness, and the ability to visualize and think abstractly.

3.4.10.C3. Illustrate the concept that not all problems are technological and not every problem can be solved using technology.

3.4.12.C3. Apply the concept that many technological problems require a multi-disciplinary approach.

3.4.10.D1. Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of a final product.

3.4.10.D2. Diagnose a malfunctioning system and use tools, materials, and knowledge to repair it.

3.4.12.D2. Verify that engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.
Month: October – December (Section/Unit – Structures)

Enduring Understanding

- Technology is not an object or artifact but a process by which we solve problems.
- Technological literacy is the ability to use, assess and manage technology around us.
- All structures have forces acting on them.
- Structures can be designed to withstand certain forces.
- Materials are chosen based on the appropriateness of their physical and chemical properties.
- Materials can be modified and developed to perform better in a given situation.

Essential Questions

- What are the forces that act on a structure?
- What are the physical properties of a material?
- How can a material be tested?

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<tr>
<td>3.2.C.A1. Differentiate between physical properties and chemical properties.</td>
<td>Structure Testing (Deck Model) - Live Loads - Dead Loads - Stress - Strain</td>
<td>Differentiate between a live and dead load on a structure - Calculate the stress and strain on a structure when a load is added</td>
<td>Written Test Testing of Model Documentation packet</td>
</tr>
<tr>
<td>3.2.C.A4. Predict how combinations of substances can result in physical and/or chemical changes.</td>
<td>Bridge Design (Balsa Bridge) - Types of Bridges - Truss - Beam - Suspension - Cable-Stayed - Cantilever - Hybrid</td>
<td>- Identify different styles of bridges and differentiate the pro’s and con’s of each style - Design a bridge that can support its own weight and added live loads</td>
<td>Testing of Model Documentation packet Grading Rubric</td>
</tr>
<tr>
<td>3.2.10.B1. Analyze the relationships among the net forces acting on a body, the mass of the body, and the resulting acceleration using Newton’s Second Law of Motion.</td>
<td>- Forces (Egg-Crash Car) - Tension - Compression</td>
<td>- Identify and define the 5 common forces that are exerted on a structure</td>
<td>Testing of Model Documentation packet Grading Rubric</td>
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</table>
3.2.10.B2. Explain how the overall energy flowing through a system remains constant.

3.4.10.A2. Interpret how systems thinking applies logic and creativity with appropriate comprises in complex real-life problems.

3.4.10.B1. Compare and contrast how the use of technology involves weighing the trade-offs between the positive and negative effects.


3.4.10.B2. Demonstrate how humans devise technologies to reduce the negative consequences of other technologies.

3.4.12.B2. Illustrate how, with the aid of technology, various aspects of the environment can be monitored to provide information for decision making.

3.4.10.C1. Apply the components of the technological design process.

3.4.10.C2. Analyze a prototype and/or create a working model to test a design concept by making actual observations and necessary adjustments.

3.4.12.C2. Apply the concept that engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.

- Bending
- Shearing
- Torsion

Material Testing
- Failure Analysis
  - Failure Mode
  - Failure Site
  - Failure Mechanism
  - Root Cause
- Material Properties
  - Elasticity
  - Plasticity
  - Brittleness
  - Malleability

- Test materials to determine their appropriateness for a given task
- Describe a material by its physical properties

Documentation packet
Grading Rubric
3.4.12.C3. Apply the concept that many technological problems require a multi-disciplinary approach.

3.4.10.D1. Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of a final product.

3.4.10.D2. Diagnose a malfunctioning system and use tools, materials, and knowledge to repair it.

3.4.12.D2. Verify that engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.

3.4.12.E5. Explain how the design of intelligent and non-intelligent transportation systems depends on many processes and innovative techniques.

3.4.10.E7. Evaluate structure design as related to function, considering such factors as style, convenience, safety, and efficiency.

3.4.12.E7. Analyze the technologies of prefabrication and new structural materials and processes as they pertain to constructing the modern world.
Month: January – February (Section/Unit – 3D Modeling and Design)

**Enduring Understanding**

- Technology is not an object or artifact but a process by which we solve problems.
- Technological literacy is the ability to use, assess and manage technology around us.
- 3D models can be used to convey a concept.
- 3D models are cheaper than prototypes.
- A 3D model can be tested like a functioning prototype.

**Essential Questions**

- How can I utilize 3D models to communicate a thought?

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| 3.4.10.A3. | 2D Drawing  
- Sketching  
- Profile Creation | - Utilize modeling software to create a 2D drawing that will act as a profile for your 3D model | Project Rubric |
| 3.4.12.A3. | 3D Rendering  
- Extrude  
- Sweep  
- Loft | - Utilize a valid profile to generate a 3D model | Project Rubric |
| 3.4.10.B1. | Modifying 3D Models  
- Hole  
- Round and Fillet  
- Shell | - Utilize basic features in a modeling software to modify a model | Project Rubric |
- Adding Views  
- Dimensioning | - Create an orthographic projection / engineering drawing from a 3D model | Project Rubric |
| 3.4.10.B2. | Assemblies | - Assemble a collection of parts into a working mechanism | Documentation packet Grading Rubric |
3.4.10.B4. Recognize that technological development has been evolutionary, the result of a series of refinements to a basic invention.

3.4.10.C1. Apply the components of the technological design process.

3.4.10.C2. Analyze a prototype and/or create a working model to test a design concept by making actual observations and necessary adjustments.

3.4.12.C2. Apply the concept that engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.

3.4.12.C3. Apply the concept that many technological problems require a multi-disciplinary approach.

3.4.10.D1. Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of a final product.

3.4.10.D2. Diagnose a malfunctioning system and use tools, materials, and knowledge to repair it.

3.4.12.D2. Verify that engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.

| Model testing | - Test a model for drag and stress  
- Test a range of motion or assembly before creating a prototype | Project Rubric |
Month: March – June (Section/Unit – Mechanisms)

**Enduring Understanding**

- Technology is not an object or artifact but a process by which we solve problems.
- Technological literacy is the ability to use, assess and manage technology around us.
- Hydraulic systems and pneumatic systems have similar properties. However, liquids do not compress.
- Suspension and power transmission are important aspects of vehicle design
- Energy has many forms and it can be converted from one form to another.

**Essential Questions**

- What is the difference between a hydraulic and pneumatic system?
- How are sub-systems developed for transportation systems?
- How can you manipulate energy to achieve a desired outcome?

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<tr>
<td>3.2.P.B1. Relate torque and rotational inertia to explain rotational motion.</td>
<td>Machine Lab Safety</td>
<td>- Safely utilize the machines and tools in the lab to create a model of a solution</td>
<td>Written Test</td>
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<tr>
<td>3.2.10.B2. Explain how the overall energy flowing through a system remains constant.</td>
<td>Control: (Hydraulic Arms) - Hydraulics / Pneumatics</td>
<td>- Utilize hydraulic concepts to change the direction and strength of a force</td>
<td>Documentation packet Grading Rubric</td>
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<tr>
<td>3.2.10.B2. Describe the work-energy theorem.</td>
<td>Automotive Design: (Monster Trucks)</td>
<td>- Create an effective energy transmission system</td>
<td>Documentation packet Grading Rubric</td>
</tr>
<tr>
<td>3.2.10.B2. Explain the relationships between work and power.</td>
<td>Energy (Rube Goldberg) - Conservation - Transfer</td>
<td>- Develop a suspension system for a vehicle</td>
<td>Documentation packet Grading Rubric</td>
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<tr>
<td>3.2.P.B2. Describe the rotational motion of objects using the conservation of energy and conservation of angular momentum.</td>
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<td>- Transfer electricity without loss</td>
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<tr>
<td>3.2.P.B2. Explain how gravitational, electrical, and magnetic forces and torques give rise to rotational motion.</td>
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<td>- Develop a circuit to power a vehicle</td>
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<tr>
<td>3.2.10.B4. Describe quantitatively the relationships between voltage,</td>
<td></td>
<td>- Design a product that changes the type and direction of energy while conserving energy through the process</td>
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current, and resistance to electrical energy and power.

3.2.10.B4. Describe the relationship between electricity and magnetism as two aspects of a single electromagnetic force.

3.4.10.A2. Interpret how systems thinking applies logic and creativity with appropriate comprises in complex real-life problems.

3.4.10.B1. Compare and contrast how the use of technology involves weighing the trade-offs between the positive and negative effects.

3.4.10.C1. Apply the components of the technological design process.

3.4.10.C2. Analyze a prototype and/or create a working model to test a design concept by making actual observations and necessary adjustments.

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3.4.10.D2. Diagnose a malfunctioning system and use tools, materials, and knowledge to repair it.

3.4.12.D2. Verify that engineering design is influenced by personal characteristics, such as creativity,
resourcefulness, and the ability to visualize and think abstractly.

3.4.10.E3. Compare and contrast the major forms of energy: thermal, radiant, electrical, mechanical, chemical, nuclear and others.

3.4.10.E5. Analyze the development of transportation services and methods and their impact on society.

3.4.12.E5. Explain how the design of intelligent and non-intelligent transportation systems depends on many processes and innovative techniques.