Milford Public Schools

Excellence ★ Honor ★ Tradition

Curriculum Map

Course Description:
This course will give students multiple experiences applying the engineering design cycle. You will design solutions to given problems, use tools to build your solutions out of materials, test your designs, and then revise them to improve their performance. The course will give students opportunities to develop important twenty-first-century skills such as collaborating with one another, identifying and working effectively with experts, honing presentation and writing skills, and learning how to complete a project on time and on budget. Students will document their learning by keeping an engineering notebook via their ePortfolio/Canva. The culminating project in the course will have students work to solve a problem of their own choosing.

Course Overview	
Concept(s)	**Big Ideas / Enduring Understanding(s)**
Engineering Design	The Engineering Design Process is a method that is used to solve technological challenges to change and improve products for the way we live. The Engineering design process is cyclical.
Critical Thinking	A problem solver understands what has been done, knows why the process was appropriate, and can support it with reasons and evidence. Career-ready individuals recognize problems in the workplace, understand the nature of the problems, and devise effective plans to solve the problems. They thoughtfully investigate the root cause of a problem prior to introducing

	solutions. They carefully consider options to solve the problem and, once agreed upon, follow through to ensure the problem is resolved.
Communication/Feedback	Communicating and cooperating with others is essential to success in school and in our community.
Collaboration	Career-ready individuals positively contribute to every team as both team leaders and team members. They understand how to delegate and take responsibility for individual tasks within a team and to assume responsibility for the team as a whole.
Research	Career-ready individuals employ research practices to plan and carry out investigations, create solutions, and keep abreast of the most current findings related to workplace environments and practices. They use a reliable research process to search for new information and confirm the validity of sources when considering the use and adoption of external information or practices.
Innovation	Career-ready individuals recommend ideas that solve problems in new and different ways and contribute to the improvement of the organization. They consider unconventional ideas and suggestions by others as solutions to issues, tasks, or problems. They discern which ideas and suggestions may have the greatest value.
Time Management	Career-ready individuals understand that making the best use of time is crucial. Students/employees will often have multiple tasks to complete at the same time and it is an important skill to be able to plan for and use time wisely to complete these tasks.
Manufacturing	*Students will apply knowledge and skills required in the application of standard manufacturing practices including planning, design and visualization. Students will learn and apply skills related to interpreting drawings, creating documentation and performing measurements. Additionally, students will employ scheduling, and practice project evaluation.*
Engineering Principles	*This unit will introduce students to fundamental engineering concepts and scientific principles associated with engineering design applications. Topics include mechanisms, energy, materials and laws of physics. Students will learn to apply problem solving, research and design skills to create solutions to engineering challenges*

At a Glance	
Unit Titles	**Length of Unit**
• The World of Engineering	1-2 weeks
• Bridges	4 weeks
• Move It! Newton's Laws of Motion	4 weeks

Unit Title	The World of Engineering	**Length of Unit**	1 week

Essential Questions	Why do engineers and designers strive to improve products used in our daily lives? Why do we use the engineering design process to solve design challenges? How can the engineering design process benefit us in solving problems in our daily lives? Why do we need more than one idea to solve a problem?
Standards	ST 3.2: Use appropriate safety techniques, equipment, and processes in planning and /or project applications ST-ET 1.1: - Apply the core concepts of technology and recognize the relationships with STEM systems (e.g., systems, resources, criteria and constraints, optimization and trade-off, and controls). ST-ET 3.2: Describe the elements of good engineering practice (e.g., understanding customer needs, planning requirements analysis, using appropriate engineering tools, prototyping, testing, evaluating and verifying). ST-ET 3.4: Illustrate the ability to characterize a plan and identify the necessary engineering tools that will produce a technical solution when given a problem statement. ST-ET 4.2: Explain the elements and steps of the design process and tools or techniques that can be used for each step. ST-ET 4.3: Describe design constraints, criteria, and trade-offs in regard to variety of conditions (e.g., technology, cost, safety, society, environment, time, human resources, manufacturability). ST-ET 5.1: Apply the design process using appropriate modeling and prototyping, testing, verification and implementation techniques. ST-ET 5.2: Demonstrate the ability to evaluate a design or product and improve the design using testing, modeling and research. ST-ET 5.3: Demonstrate the ability to record and organize information and test data during design evaluation ST-ET 6.2: Apply the process and concepts for science literacy relative to engineering and technology. Sample Indicators: NGSS: HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them.
Key Vocabulary	Define, customer-needs/requirements, problem-solving, solutions, brainstorming, research/explore, constraints/limitations, efficiency, budget, collaborate/design, dimensions, sketch/Technical drawing, create, prototype, test/evaluate, improvements/iterations, feedback/communication.

Critical Content ***Students will KNOW…***	**Key Skills:** ***Students will be able to (DO)…***
• Each step of the Engineering Design Process	• Identify which step of the process they are working on.
• There is no such thing as a perfect design.	• Create a solution to a given problem
• How to communicate their ideas/solutions	• Focus on each step of their design/ideas
• Why time management/budgeting is so important	• Use time efficiently. Use a bill of materials to budget cost effectively.
• Failure allows for growth	• Learn from what doesn't work. Failure is built into the process to allow for improvements.

Evidence of Learning: ***(Student learning will be measured by . . .)***	Students will create an engineering page/journal in their ePortfolio focusing on the unit essential questions.

Unit Title	**Bridges**	**Length of Unit**	4 weeks

Essential Questions	
Standards	ST 3.2: Use appropriate safety techniques, equipment, and processes in planning and /or project applications ST-ET 1.1: - Apply the core concepts of technology and recognize the relationships with STEM systems (e.g., systems, resources, criteria and constraints, optimization and trade-off, and controls). ST-ET 3.2: Describe the elements of good engineering practice (e.g., understanding customer needs, planning requirements analysis, using appropriate engineering tools, prototyping, testing, evaluating and verifying). ST-ET 3.4: Illustrate the ability to characterize a plan and identify the necessary engineering tools that will produce a technical solution when given a problem statement. ST-ET 4.2: Explain the elements and steps of the design process and tools or techniques that can be used for each step.

	ST-ET 4.3: Describe design constraints, criteria, and trade-offs in regard to variety of conditions (e.g., technology, cost, safety, society, environment, time, human resources, manufacturability). ST-ET 5.1: Apply the design process using appropriate modeling and prototyping, testing, verification and implementation techniques. ST-ET 5.2: Demonstrate the ability to evaluate a design or product and improve the design using testing, modeling and research. ST-ET 5.3: Demonstrate the ability to record and organize information and test data during design evaluation ST-ET 6.2: Apply the process and concepts for science literacy relative to engineering and technology. Sample Indicators: NGSS: HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics ITEEA.9.F Design involves a set of steps, which can be performed in different sequences and repeated as needed. ITEEA.9.G Brainstorming is a group problem-solving design process in which each person in the group presents his or her ideas in an open forum. ITEEA.9.H Modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions. ITEEA.11.H Apply a design process to solve problems in and beyond the laboratory-classroom. ITEEA.11.L Make a product or system and document the solution. ITEEA. 13.F Design and use instruments to gather data. ITEEA.13.G Use data collected to analyze and interpret trends in order to identify the positive and negative effects of a technology. ITEEA.13.H Identify trends and monitor potential consequences of technological development. ITEEA.13.I Interpret and evaluate the accuracy of the information obtained and determine if it is useful
Key Vocabulary	Static load, dynamic load, span, load, tension, compression, torsion, shear, truss, abutment, pier, beam, butt joint, miter joint, lap joint, lamination, racking, scale, side view, top view, substructure, roadbed, dimension, criteria, constraints,

Critical Content ***Students will KNOW…***	**Key Skills:** ***Students will be able to (DO)…***
• The history of bridges in our world	• Describe the benefits and need for bridges throughout the world
• The 5 most common types of bridges.	• Describe beam, truss, arch, and suspension, and cable-stayed bridges.

• The difference between top and side view sketches	• Create drafts of top and side view of bridge design
• Different joints result in different levels of strength	• Make strong structures and discover properties of various materials
•	•

Evidence of Learning: ***(Student learning will be measured by . . .)***	Design and construct a model wood bridge with design constraints. Determine the truss type, beam lengths, and beam angles to hold the maximum load possible.

Unit Title	**Simple Machines** **Move It! Newton's Laws of Motion**	**Length of Unit**	4 weeks

Essential Questions	What is one thing we want to accomplish whenever we have to work? Why are engineers interested in simple machines? What is work? What are units of force?
Standards	**MS-ETS1-1**. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. **MS-PS2-2.** Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. CCSS: Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association. CCSS: Fluently add, subtract, multiply, and divide multi-digit decimals using the standard algorithm for each operation. NGSS: HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics ITEEA.9.F Design involves a set of steps, which can be performed in different sequences and repeated as needed.

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Key Vocabulary	Inclined plane, wedge, screw, lever, pulley, wheel and axle, specification, speed, slope, acceleration, force, mass, momentum, interia, energy, collision

Critical Content ***Students will KNOW…***	**Key Skills:** ***Students will be able to (DO)…***
• That there are 6 simple machines that make work easier	• Recognize, identify and explain why engineers are interested in the six simple machines.
• Force x distance = work	• Define the concept of work as it relates to mechanical advantages
• What an inclined plane, wedge and screw does.	• Explain how the mechanical advantages of inclined plane, wedge and screw make work easier.
• What a lever, pulley, and wheel and axle does.	• Explain how the mechanical advantages of lever, pulley, and wheel-and-axle make work easier.
• Newton's Laws of Motion	• Understand and take advantage of the concepts of forces.

Evidence of Learning: ***(Student learning will be measured by . . .)***	Build a small Rube Goldberg machine using their knowledge of simple machines and the engineering design process. Use the engineering process to create a safe car to protect a raw egg passenger in multiple head on collisions.