Mehlville School District

*Individually Focused. Committed to All.*

# Engineering Essentials



BOE Approval Required to Change

**General Course Information**

| **Course Name: Engineering Essentials** | |
|---|---|
| Department: Technology & Engineering | Grade Level(s): 9-12 |
| Duration/Credits: 1 year/ 1.0 credits | Prerequisites: Concurrently enrolled in Algebra I or higher. (Practical Arts) Weighted: 0.75 |
| BOE Approval Date: | Course Code: |

**Course Description:**

In Engineering Essentials, students explore the work of engineers and their role in the design and development of solutions to real-world problems. The course introduces students to engineering concepts that are applicable across multiple engineering disciplines and empowers them to build technical skills through the use of a variety of engineering tools, such as geographic information systems (GIS), 3-D solid modeling software, and prototyping equipment. Students learn and apply the engineering design process to develop mechanical, electronic, process, and logistical solutions to relevant problems across a variety of industry sectors, including health care, public service, and product development and manufacturing.

**Course Rationale:**

Today we live in the Age of Information with new inventions, improvements, and discoveries occurring exponentially every day. With the advancements of technology and the development of new materials, come more opportunities to broaden people's abilities to function more readily in society. Technology such as calculators, computers, and mechanical pencils are evidence of the improvements made possible by the work of many types of engineers. This class will provide opportunities for the student to build and integrate basic knowledge and life skills that are essential in the study of engineering in our ever changing world of technology. This course will also offer an entry point into other advanced engineering tracks as well as the biomedical and computer science tracks through PLTW.

**Course Objectives:**

- The student will properly document the progression of projects in the course, including design process, mathematical thinking, business plans, drawings, and reflections in a written journal/notebook. (A+ Writing)
- The student will give and receive feedback on projects, journal entries, and

business plans. (A+ Speaking and Listening)
- The student will collaborate to create community networks and partnerships to practice soft skills (such as communication, locating resources, developing mentors) and support the robotics program.
- The student will design and manufacture a fully-functioning robot capable of solving real world problems within given constraints.
- The student will research problem-solving approaches to determine the appropriate mathematical, engineering, and planning strategies to apply to the manufacture and programming of the robot. (A+ Research)
- The student will maintain a safe and clean working environment.

- The student will read and interpret technical journals, blueprints, and grant applications. (A+ Reading)
- The student will collaborate with fellow students to write applications and apply for grants.
- The student will follow all safety procedures and rules in the shop environment.

**Standards Alignment:**

Course is from PLTW - (Project Lead The Way) and is nationally normed.

**Power Standards**

List Standards - Students will:

- Solve a problem using an iterative engineering design process (A+ Research)
- Work collaboratively on a team to design a product or solve a problem (A+ Speaking)
- Document in detail the engineering design process used to solve a problem or design a product (A+ Writing)
- Develop a detailed and comprehensive design brief (A+ Reading, A+ Writing)
- Brainstorm to generate creative ideas and potential solutions to a problem
- Carry out a plan to compare alternate solutions and select the best solution path
- Evaluate a design solution with respect to design requirements
- Design an experimental protocol to investigate a phenomenon and gain knowledge
- Develop a test plan to compare alternate solutions
- Collect and analyze data to draw conclusions
- Accurately represent experimental data using proper visualization techniques and statistical models
- Create concept sketches to represent ideas
- Create hand-drawn and scaled technical drawings of simple objects
- Create and/or modify 3-D solid computer models of complex parts
- Use GIS technology to interpret spatial information, collect geocoded data, and identify patterns
- Construct and use maps to make engineering decisions
- Conduct a feasibility study for the location of a facility
- Design a story map to present GIS-informed design solutions
- Apply systems thinking to consider how an engineering problem and its solution may be thought of as containing subsystems and as being a subsystem of a larger system
- Assess the sustainability of an engineering solution based on the impacts – within the system or interrelated systems – that result from implementation of the solution
- Apply project management tools – including a project schedule and collaborative tools – when designing and developing a solution
- Act as a project lead to solve an engineering problem
- Develop models (including conceptual, graphical, mathematical, physical, and computer) and simulations to represent information, objects, electrical circuits, systems, and processes
- Identify the purpose and limitation of a given model
- Use models to inform a design process and create solutions
- Develop physical models (including 3-D printed parts) to represent natural phenomenon, mechanical systems, and electromechanical systems
- Apply problem decomposition skills to break problems and processes into

manageable parts
- Use algorithms to create solutions with or without computer programs
- Use Excel to calculate summary statistics, create histograms, and find trend lines
- Formulate solutions that use automation and programming to solve a problem
- Collect, organize, and analyze data to help define a problem
- Apply abstraction to generalize a problem and solutions
- Use data to inform decisions and make predictions
- Build a circuit physically and virtually
- Measure circuit parameters
- Perform circuit calculations using Ohm's Law
- Build truth tables and assemble logic circuits
- Program a microcontroller
- Design and build an electromechanical system

| **Unit I**: Inclined to Design | **Duration:** |
|---|---|
| **Unit Description:** Unit 1 introduces students to foundational cross- disciplinary engineering concepts, empowers them to develop and strengthen their transportable skills, and exposes them to global engineering challenges that the next generation will face. Throughout the unit, students will imagine themselves as engineers and envision a future in which they can make a difference in the world. Students learn the engineering design process and have the opportunity to apply that process to multiple projects and problems throughout the unit as they improve their communication and collaboration skills. They reflect on design problems and solutions from a systems perspective and investigate ethics as they consider the impact of engineering decisions. Students also learn basic skills associated with project management, including developing a project schedule and critical path analysis to help them plan and track progress during larger projects. They use a geographic information system as a tool to help identify, define, and solve problems using spatial information. | |
| **Unit Standards** | **Key Learning Targets** |
| • | I can . . .<br>• |
| **Essential Questions** | **Enduring Understandings** |
| | |
| **Resources:** | |
| **Previous knowledge and skills needed:** | |
| **Key Unit Vocabulary:**<br>1. | |
| **Additional Information:** | |

| | |
|---|---|
| **Unit II**: Make it Move | **Duration:** |
| **Unit Description:** In Unit 2, students apply mechanical and mathematical concepts to design solutions to engineering problems. They develop multiple types of models to represent aspects of real objects/phenomena, including conceptual models, graphic models (drawings), 3-D solid computer models, physical models, and mathematical models, and begin to understand the inherent limitations of each. These models are used to define, test, and communicate design ideas and mechanical solutions.<br>Students build on skills and knowledge gained from Unit 1 and have additional opportunities to apply the design process, experimental design, systems thinking, and project management to design and test mechanical solutions to improve people's lives. Students continue to develop their collaboration and communication skills and consider the impact of their solution on people and society. | |
| **Unit Standards** | **Key Learning Targets** |
| Insert unit standards | Insert learning targets |
| **Essential Questions** | **Enduring Understandings** |
| Insert essential questions | Insert enduring understandings |
| **Resources:** | |
| **Previous knowledge and skills needed:** | |
| **Key Unit Vocabulary:** | |
| **Additional Information:** | |

| **Unit III**: Power it Up | **Duration:** |
|---|---|
| **Unit Description:** In Unit 3, students discover the foundation of all modern electronic devices, such as cellular phones, MP3 players, and high-definition televisions. Students learn how to use digital circuits to develop electronic solutions that improve people's lives.<br>Students review energy forms and the transfer of energy into the form of electricity. They investigate the fundamental circuit components, concepts, equipment, and skill set associated with circuit design. Students use graphical, computer, and physical models to represent and investigate analog circuits. Students design experiments to determine the relationship among voltage, current, and resistance in circuits. They are then introduced to the basics of digital signals, starting with truth tables and logic expressions, then apply the design process to design, simulate, and breadboard a circuit to accomplish a goal. Finally, students collaborate and work with other teams as they apply skills and knowledge learned in prior units to develop a proof of concept prototype for an electromechanical system. | |
| **Unit Standards** | **Key Learning Targets** |
| Insert unit standards | Insert learning targets |
| **Essential Questions** | **Enduring Understandings** |
| Insert essential questions | Insert enduring understandings |
| **Resources:** | |
| **Previous knowledge and skills needed:** | |
| **Key Unit Vocabulary:** | |
| **Additional Information:** | |

| **Unit IV**: Make a Plan | **Duration:** |
|---|---|
| **Unit Description:** In Unit 4, students investigate issues related to population growth and development, and use geographic information systems as tools to define, model, and solve engineering challenges that result from development. | |
| **Unit Standards** | **Key Learning Targets** |
| Insert unit standards | Insert learning targets |
| **Essential Questions** | **Enduring Understandings** |
| Insert essential questions | Insert enduring understandings |
| **Resources:** | |
| **Previous knowledge and skills needed:** | |
| **Key Unit Vocabulary:** | |
| **Additional Information:** | |

| **Unit V**: | **Duration:** |
|---|---|
| **Unit Description:** | |
| **Unit Standards** | **Key Learning Targets** |
| Insert unit standards | Insert learning targets |
| **Essential Questions** | **Enduring Understandings** |
| Insert essential questions | Insert enduring understandings |
| **Resources:** | |
| **Previous knowledge and skills needed:** | |
| **Key Unit Vocabulary:** | |
| **Additional Information:** | |

| **Unit VI**: | **Duration:** |
|---|---|
| **Unit Description:** | |
| **Unit Standards** | **Key Learning Targets** |
| Insert unit standards | Insert learning targets |
| **Essential Questions** | **Enduring Understandings** |
| Insert essential questions | Insert enduring understandings |
| **Resources:** | |
| **Previous knowledge and skills needed:** | |
| **Key Unit Vocabulary:** | |
| **Additional Information:** | |

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