Fair Lawn

Public Schools

Fair Lawn, NJ

Engineering & Design

August

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The focus of the Engineering and Technology Department is to promote the development of **innovation** skills in all students. This is an introductory course in which students will learn and apply engineering and design skills, address real-world problems, and conduct career exploration.

Engineering & Technology Education

Learn. Innovation.

Fair Lawn School District

Committee Credits

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Engineering & Design

I. Course Synopsis

Engineering and Design is an introductory course in which students will study and apply the design loop to explore various career fields within engineering. They will be introduced to real-world problems and applications of the engineering to address those problems.

II. Philosophy & Rationale

This course has been aligned to and developed with the NJSLS for Technology as it's major focus, with a supplemental focus on the Standards for Technological Literacy for the Content Study of Technology (ITEA). In addition, the NJSLS-S, particularly in physical science and engineering and design have been addressed along with the NJSLS-ELA for literacy in science and technical subjects and math. This demonstrates the integral nature of engineering into "STEM" education.

"Innovation" is defined as *the act or process of introducing new ideas, devices, or methods*". The philosophy of the Engineering and Technology Department to focus on the development of innovation in all students through the application of true, STEM education.

Differentiated instruction for students at different levels of achievement and specific learning needs (e.g. special education, English Language Learners (ELL), at-risk, and Gifted & Talented) is embedded in targeted scaffolding based on knowledge of each student's interests, needs, and assessment data, including, but not limited to, in class formative and summative assessments. Students in these courses are provided with clear, concise rubrics which describe and define expectations for project based, authentic assessment which involves written and/or performance based requirements.

When deemed appropriate, department teachers will engage students in purposeful paired discussions to share information more effectively, such as the "turn and talk" (Harvey & Daniels, 2009). "Text annotation" could be used, for example to optimize reading comprehension (Daniels & Steineke, 2010).

III. Scope & Sequence

Engineering & Design serves as an introductory course in which each unit will focus on a key component of the fields of engineering with a consistent focus on the design loop throughout the course.

Unit 1: Engineering Safely (September)

- The safe use of tools, equipment and machines is essential for effectively applying the engineering process.

Unit 2: What is Engineering & Design? (September - October)

- Engineering is the application of math and science to solve real world problems.
- The design loop can be applied to continually improve upon their designs and ideas.

Unit 3: Fields of Engineering (October - December)

- Various fields of engineering exist.
- Each field of engineering employs similar techniques to solve different types of problems.

Unit 4: How do Forces Affect Objects? (January-February)

- Every constructed object is affected by force.
- Engineers must design with force in mind to ensure safe products.

Unit 5: Design in Engineering (February-March)

- Form must be considered during the design process and with regard to the final product.

Unit 6: How has Technology Changed the World (April-May)

- Applying engineering to solve problems also may result in environmental concerns.
- Technology causes culture and society to change.

Unit 7: Applications of Engineering (May-June)

- Engineering skills may be applied to address real world problems.

IV. Unit Descriptions

Unit 1: Engineering Safely (1 Week)*

Enduring Understandings

1. The safe use of tools, equipment and machines is essential for effectively applying the engineering process.

Essential Questions:

1. How are tools, equipment and machines used safely?

Learning Objectives:

1. Identify tools, equipment, machines and their uses.
2. Identify and demonstrate how to safely use tools, equipment, and machines.

Suggested Activities & Suggested Modifications for Special Education Students, ELL Students, Students at Risk, and Gifted Students:

1. Practical exam on proper use of key tools, equipment and machines.
2. Modifications may include providing students with a template, diagrams, and additional resources for special education and ELL students.
3. Gifted students may be asked to assist their classmates in tool, equipment and machine identification.

Cross-Content Connections:

Standards for Technology Literacy (9-12)– 8H-K: Applying the Design Loop; 9I-K: Prototyping

NJSLS-Companion Standards for English & Language Arts: 9-10; 11-12:

A focus in this unit will be following multistep processes.

***Safety will be stressed and monitored throughout the course.**

Unit 2: What is Engineering & Design? (2-3 Weeks)

Enduring Understandings

1. Engineering is the application of math and science to solve real world problems.
2. The design loop can be applied to continually improve upon their designs and ideas.

Essential Questions:

2. How can math and science be applied to solve real world problems?
3. How does the function of the design loop aid engineers in the design process?

Learning Objectives:

3. Define engineering as the application of math and science to solve real world problems.
4. Describe and apply the steps of the design loop to complete the design of a usable finished product. (8.2.12.C.1)
5. Analyze a product and describe how it has changed over time to meet human needs and wants, such as a sneaker. (8.2.12.C.2)
6. Compare and contrast the concepts of "engineering design" with "design".
7. Apply techniques such as product poling, research, ergonomics, material selection, measurement, CADD, mechanical drawing, and/or 3D modeling to the design process. (8.2.12.C.3; 8.2.12.C.5.8.2.12.D.2, 8.2.12.D.3)

Suggested Activities & Suggested Modifications for Special Education Students, ELL Students, Students at Risk, and Gifted Students:

4. Design/Marketing Activity
5. Modifications may include providing students with a template to support the process.
6. Gifted students may be asked to present their product to an official representative or enter a contest.

Cross-Content Connections:

Standards for Technology Literacy (9-12) – 8H-K: Applying the Design Loop; 9I-K: Prototyping

NJSLS-Science- A focus in this unit will be on the real world applications of technology (HS-ETS).

NJSLS-Companion Standards for English & Language Arts: 9-10; 11-12:

A focus in this unit will be following multistep processes, key idea development and craft/structure.

NJSLS-Math:

A focus in this unit will be on geometry, particularly the use of right triangles.

A focus in this unit will be on numbers and quantities, particularly for the use of measurement.

Unit 3: Fields of Engineering (5-6 Weeks)

Enduring Understandings

1. Various fields of engineering exist.
2. Each field of engineering employs similar techniques to solve different types of problems.

Essential Questions:

1. How do engineers in each field apply the design loop to solve different types of problems?

Learning Objectives:

1. Differentiate between the focus of mechanical, electrical, civil, biomedical, chemical, and design engineering.
2. Apply the technical skills of each field of engineering to solve a real-world problem, such as:
    a. Mechanical: Rube Goldberg Design Challenge
    b. Electrical: Mag-Lev & Self-Propelled Vehicles
    c. Civil: Structure Building
    d. Bio-Medical: 3D Printed Joint (8.2.12.D.1)
    e. Chemical: Oil Spill Project
3. Apply the design loop to design, build, test, collect data, and redesign, solutions to problems.
4. Explain interdependent systems and their functions such as in electrical engineering. (8.2.12.C.4)

Suggested Activities & Suggested Modifications for Special Education Students, ELL Students, Students at Risk, and Gifted Students:

1. See #2 Above
2. Modifications may include providing students with a template or to support the process and/or design specifications with reduced variables.
3. Gifted students may be asked to complete additional steps or address additional variables.

Cross-Content Connections:

Standards for Technology Literacy (9-12)– 8H-K: Applying the Design Loop; 9I-K: Prototyping; 10I-L: Other Problem Solving Approaches

NJSLS-Science- A focus in this unit will be on the real world applications of technology (HS-ETS).

NJSLS-Companion Standards for English & Language Arts: 9-10; 11-12:

A focus in this unit will be following multistep processes, key idea development and craft/structure.

NJSLS-Math:

A focus in this unit will be on geometry, particularly the use of right triangles.

A focus in this unit will be on numbers and quantities, particularly for the use of measurement.

Career Readiness Practices: A key idea in this unit is the focus on career exploration (NJSLS 9.2).

Unit 4: How do Forces Affect Objects? (5-6 Weeks)

Enduring Understandings

1. Every constructed object is affected by force.
2. Engineers must design with force in mind to ensure safe products.

Essential Questions:

1. How do forces affect rockets and cars?
2. How do engineers problem solve to address the effects of force?

Learning Objectives:

1. Describe Newton's Three Laws of Motion.
2. Apply the principles of motion to solve a design problem.
3. Analyze the effects of various forces on different constructed objects.
4. Explain how material processing impacts the quality of engineered and fabricated products. (8.2.12.D.5)

Suggested Activities & Suggested Modifications for Special Education Students, ELL Students, Students at Risk, and Gifted Students:

1. CO_2 Dragsters & Rockets / White Box Learning
2. Modifications may include providing students with a template or to support the process and/or design specifications with reduced variables.
3. Gifted students may be asked to complete additional steps or address additional variables.

Cross-Content Connections:

Standards for Technology Literacy (9-12)– 16 Energy & Power Technologies & 18 Transportation Technologies

NJSLS-Science- A focus in this unit will be on the real world applications of technology (HS-ETS) and energy (HSPS3)

NJSLS-Companion Standards for English & Language Arts: 9-10; 11-12:

A focus in this unit will be following multistep processes, key idea development and craft/structure.

NJSLS-Math:

A focus in this unit will be on geometry, particularly the use of right triangles.

A focus in this unit will be on numbers and quantities, particularly for the use of measurement.

Career Readiness Practices: A key idea in this unit is the focus on career exploration (NJSLS 9.2).

Unit 5: Design in Engineering? (5-6 Weeks)

Enduring Understandings

1. Design must be considered during the design process and regarding the final product.

Essential Questions:

1. How does form affect function, when does it supercede it?
2. Identify design within Engineering and the engineering of design.

Learning Objectives:

1. How do engineers and designers approach a problem the same, and how do they do so differently?
2. Identify a scenario in which form is more important than function, how and why does this work?
3. Identify when aesthetic considerations become more important than inherent functionality.

Suggested Activities & Suggested Modifications for Special Education Students, ELL Students, Students at Risk, and Gifted Students:

1. Profile Vehicle Re-Design.
2. Modifications may include providing students with a template, diagrams, and additional resources for special education and ELL students.
3. Gifted students may be asked to assist their classmates in critical thinking relative to design process.

Cross-Content Connections:

Standards for Technology Literacy (9-12)– 8 Attributes of Design

NJSLS-Science- A focus in this unit will be on the

real world applications of technology (HS-ETS) and energy (HSPS3)

NJSLS-Companion Standards for English & Language Arts: 9-10; 11-12:

A focus in this unit will be following multistep processes, key idea development and craft/structure.

NJSLS-Math:

A focus in this unit will be on geometry, particularly the use of right triangles.

A focus in this unit will be on numbers and quantities, particularly for the use of measurement.

Career Readiness Practices: A key idea in this unit is the focus on career exploration (NJSLS 9.2).

Unit 6: How has Technology Changed the World (5-6 Weeks)

Enduring Understandings

1. Applying engineering to solve problems also may result in environmental concerns.
2. Technology causes culture and society to change.

Essential Questions:

1. How does new technology affect the environment?
2. How can engineers develop technology in an environmentally friendly manner?
3. How does technology affect culture and society?

Learning Objectives:

1. Observe the cause and effect relationship between specific technologies and the environment over time. (8.2.12.B.1)
2. Compare and contrast two technological devices and their impact on the environment. (8.2.12.B.2)
3. Apply their understanding of the design loop and technologies impact on humans to create a device that impacts culture and society in a positive manner. (8.2.12.B.3)
4. Justify and explain their individual device discussing the positive and negative impacts it may have on society. (8.2.12.B.3)

Suggested Activities & Suggested Modifications for Special Education Students, ELL Students, Students at Risk, and Gifted Students:

1. Bio-technology, robotics, alternative energy
2. Modifications may include providing students with a template or to support the process and/or design specifications with reduced variables.
3. Gifted students may be asked to complete additional steps or address additional variables.

Cross-Content Connections:

Standards for Technology Literacy (9-12)– 15 Agricultural & Related bio-technologies, 16 Energy & Power Technologies; 4 Cultural, Social, Economic, and Political Effects of Technology; 5 Effects of Technology on Environment; 6 Role of Society

NJSLS-Science- A focus in this unit will be on the real world applications of technology (HS-ETS)

NJSLS-Companion Standards for English & Language Arts: 9-10; 11-12:

A focus in this unit will be following multistep processes, key idea development and craft/structure.

NJSLS-Math:

A focus in this unit will be on geometry, particularly the use of right triangles.

A focus in this unit will be on numbers and quantities, particularly for the use of measurement.

Career Readiness Practices: A key idea in this unit is the focus on career exploration (NJSLS 9.2).

Unit 7: Applications of Engineering (5-6 Weeks)

Enduring Understanding

1. Engineering skills may be applied to address real world problems.

Essential Questions:

1. How can engineering be applied to improve a local issue?

Learning Objectives:

1. Identify a local engineering problem.
2. Apply the design loop to address the problem. (8.2.12.B.1, 2, 3)
3. Integrate current engineering principles to develop a reasonable solution.
4. Present a solution in a realistic situation.
5. Analyze a current technology and the resources used to identify trade off. (8.2.12.A.2)

Suggested Activities & Suggested Modifications for Special Education Students, ELL Students, Students at Risk, and Gifted Students:

1. Identification of Problem & Designing A Solution
2. Modifications may include providing students with a template or to support the process and/or design specifications with reduced variables.
3. Gifted students may be asked to complete additional steps or address additional variables.

Cross-Content Connections:

Standards for Technology Literacy (9-12)– Culmination of All

NJSLS-Science- A focus in this unit will be on the real world applications of technology (HS-ETS)

NJSLS-Companion Standards for English & Language Arts: 9-10; 11-12:

A focus in this unit will be following multistep processes, key idea development and craft/structure.

NJSLS-Math:

A focus in this unit will be on geometry, particularly the use of right triangles.

A focus in this unit will be on numbers and quantities, particularly for the use of measurement.

Career Readiness Practices: A key idea in this unit is the focus on career exploration (NJSLS 9.2).

V. Course Materials

Core (Required) Texts

Technology Engineering & Design (2008) Pearson
Will be used as a classroom reference book.

Understanding Technology (1993) Goodheart-Wilcox
Will be used as a classroom reference book.

VI. Assessments

Classroom assessments are included to primarily guide instruction (formative assessment) and to support decisions made beyond the classroom (summative assessment).

Summative assessment will be authentic in nature. Students will be asked to complete design challenges and other performance based assessments. These assignments will typically involve a design, build, test, and redesign competent. Assessment will be rubric based.

VII. Interdisciplinary Connections and Alignment to Technology Standards

Interdisciplinary connections have been noted within each unit in the previous pages.

Careful attention will be paid in this course to form meaningful connections between the application of literacy for technical subjects, math skills and standards, career exploration, and the NJSLS-S.

Engineering & Technology Education classes in the Fair Lawn Public schools promote career-readiness skills related to Personal Financial Literacy (9.1) and Career Awareness, Exploration, and Presentation (9.2). Some course concepts from the Career and Technical Education Standards (9.3), but these are not directly correlated since our district is not a CTE program.

The Fair Lawn Public Schools District fosters an environment that promotes career-readiness skills in all content areas. Whereas Career Ready Practices are explored consistently, specific alignment to Personal Finance Literacy (9.1) and Career Awareness, Exploration, and Presentation Standards (9.2) are included in the district level document (below). When appropriate, the Career and Technical Education Standards (9.3) have been reviewed and aligned as well.

Examples: 9.2B: Career exploration in each unit of study.

In addition, every effort is made to integrate technology and engineering into our science classes. Educational Technology (8.1) and Technology Education, Engineering, Design, and Computational Thinking – Programming (8.2) standards are cross connected throughout our science programs.

Examples:
- 8.1A: Use spreadsheets to analyze & interpret data from laboratories, 6-12.
  Use the internet to increase productivity and efficiency, 9-12.
- 8.1B,C: Use data to solve real-world problems, 6-12.
  Use online platforms to collaborate & address global issues, 9-12.
- 8.1F: Collect and analyze data using internet and data simulations, 6-12.
- 8.2A: Become aware of the invention process, 3-5.
- 8.2B: Become aware of the global impacts on technology, 6-12.
- 8.2C: Apply the design process to pushes & pulls, K-2.
- 8.2D: Use tools to reduce work, K-2.

For additional detail on how these standards are integrated throughout the Fair Lawn Schools curriculum, review the Fair Lawn Public Schools District Alignment to Technology & Career Readiness & 21st Century Skills Standards Curriculum Appendix.