

Course Number:

Discipline: Science/Green Engineering

Grade Level: Grades 10-12

Course Length: One Semester

Credits: 3.0

Course Description: *This is an inquiry-based course designed to meet the Massachusetts state standards for Technology/Engineering. Course design challenges are presented and completed through class discussion and demonstration, cooperative group research, and project based discovery. Green Engineers use the design process to develop and test their own environmentally friendly design solutions to everyday problems. 'Green Engineering is where Engineering, Sustainability, Economics and Aesthetics Meet'. Students in this course will participate in engineering design challenges designed to foster critical thinking and effective communication skills while developing sustainable and eco-friendly solutions for today's problems. No prior experience is assumed for this course, only a keen interest and a strong motivation to learn.*

Science and Engineering Practices:

1. Defining problems
2. Developing and using models
3. Planning and carrying out investigations
4. Designing eco-friendly solutions
5. Engaging in argument from evidence
6. Obtaining, evaluating, and communicating information

21st Century Student Learning Expectations:

- *Develop idea creation techniques (ex: brainstorming) to create new and worthwhile ideas*
- *Develop, implement and communicate new ideas to others effectively.*
- *Identify and ask questions that clarify various points of view and lead to better solutions*
- *Elaborate, refine and evaluate ideas in order to improve and maximize creative efforts*
- *Act on creative ideas to make a useful contribution to a specific engineering field*
- *Be open and responsive to new and diverse perspectives; incorporate group input and feedback into the work. Respond open-mindedly to different ideas and values*
- *Set and meet goals; prioritize, plan, and manage work to achieve the intended result*
- *Solve different kinds of non-familiar problems in both conventional and innovative ways*
- *Evaluate information critically and competently; use information accurately and creatively for the issue at hand*
- *Use technology as a tool to research, organize, evaluate and communicate information*

Unit 1: What is Green Engineering?

Engineers are problem solvers. They look at a problem or dream of an idea and take specific steps to innovate solutions. Green Engineers use engineering steps and include sustainable methods based on protecting, repairing, and even copying nature. Green engineers always consider ways to implement eco-sustainable and safe solutions.

Enduring Understanding:	<ul style="list-style-type: none"> The design process is a systematic process of planned change. It is a logical problem solving technique that is useful in all aspects of life, not just in engineering fields. Engineering design involves practical problem solving, research, development, and invention/innovation, and requires designing, drawing, building, testing, and redesigning. Green Engineers use the engineering design steps and include methods and materials that are sustainable and safe for the environment. Any field of engineering can incorporate green engineering methods
Essential Questions:	<ol style="list-style-type: none"> What is green engineering and how can it be used to solve problems? What are the possible types of careers for a green engineer?
MA Frameworks <i>HS-ETS1-2</i> <i>HS-ETS1-1. Analyze a major global challenge to specify a design problem that can be improved.</i>	Unit Objectives: <ul style="list-style-type: none"> Test and summarize the engineering design process. <i>HS-ETS1-2</i> Explore Types of engineering fields and explain how each can be 'green' <i>HS-ETS1-1</i>
Assessment Activities:	Tower Challenges (Options) Engineer journal , Green Engineer Careers Brochure Tower Front Page News
Vocabulary:	Engineer, Sustainable
Common Activities/Labs:	Tower challenges
Project Based Activities:	Build towers (Options) Types of Engineers project

Unit 1: What is Green Engineering?

Instructional Strategies and Timeline: 5-6 Days

Day 1: Marshmallow pasta tower (*maybe do this one on first day*)

- Check in- design steps
- Introductions

Day 2: Notes: Importance of Journals and photos

Class Rules and Syllabus

[Tower Challenge](#)

Modified Team [Tower Challenges](#)

Day 3: How to make a [Front Page](#) News

Day 4 Peer News Edits and Fields of Green (engineers)

Fields of Green (Engineers) group presentation [Link for engineer topics](#)

Choose one for brochure research

[rubric](#)

Day 5 Give 1 - Get 5 Fields of Green (Engineers)

Front Page news Due

Assessments:

- Build a tower- [Engineer journal \(Options\)](#)
- [Front Page](#) News for tower
- [Participation Rubric](#)
- Greened Engineer Brochure

Unit 2: Reduce Reuse Repurpose

Green engineers address overconsumption problems by learning how to minimize their consumption and use upcycling. Using the “cradle to cradle” design solves many sustainability problems and minimizes the creation of new problems over time.

Enduring Understanding:	It requires more than recycling to make the world a healthier place. Thoughtful design and consumption can have a positive impact on protecting and improving life on earth.
Essential Questions:	<ol style="list-style-type: none"> 1. How do the four “R’s” apply to green engineering? 2. What can we do about plastics? 3. How can an engineer have a green lifestyle? 4. How can we solve real world problems using green engineering design steps?
(#) MA Frameworks HS-ETS1-1. Analyze a major global challenge to specify a design problem that can be improved. HS-ETS1-2. Break a complex real-world problem into smaller, more manageable problems that each can be solved using scientific and engineering principles	Unit Objectives: <ol style="list-style-type: none"> 1. Judge the state of the four R’s(Reduce, Reuse, Recycle, Redesign) HS-ETS1-1 2. Explore types of plastics - where they come from, where they go, and how we can transform them. HS-ETS1-1 3. Evaluate bad packaging and develop a new design HS-ETS1-1 4. Develop a solution to our personal contributions to the waste stream.HS-ETS1-2
Assessment Activities:	Types of plastics presentation Upcycle: Fused Plastic Challenge Reuse: Sew Challenging Reduce: Lifestyle reflection, Bad Designs Project Front page News Participation
Vocabulary:	Upcycle, Downcycle, Textile, fossil fuel, HDPE, LDPE
Common Learning Activities/Labs:	Challenge Journal Upcycle: ‘Types of Plastics’ group presentations Student brainstorm Presentation of DIY Fused plastic Reduce: The Story of Stuff reflection Story of Stuff Video
Project Based Learning Activities:	<ul style="list-style-type: none"> • Fused Plastic Project • Sew Challenging project
Resources	Unit Notes: Reduce Reuse Upcycle

Unit 2: Reduce, Reuse, Repurpose

Instructional Strategies and Timeline: 18 days

Day 1

- Recycle- [Notes and plastics video](#)
- [What is plastic?](#)
- Types of Plastics research
- Upcycle- Fused Plastic Brainstorm

Day 2-5

- Fused Plastic Challenge (6 Days)
- [Feedback Loop Report](#)

Day 6

- Work on Fused Plastic [Front Page](#) News

Day 7

- Types of Plastic Presentations
- Fused Presentations

Day 8

- [Product Packaging Redesign? Activity](#) (24 products)
- [Bad Designs Modified](#) activity Presentation
- [Bad Packaging PSA](#)
- HW: [Minimalist Lifestyle facts and Reflection](#) - due Day 13

Day 9

- Present Bad Packaging: Give 1- Get 4
- Story of stuff
- Waste = Food video

Day 10 Simple Life Roundtable

Day 11-16

- How to use a sew machine /basics
- [Link to Repurpose clothes brainstorm presentation](#)
- Make a sewing design template/pattern
- Sew Challenging production and journal
- [Feedback Loop Report](#)

Day 17 Make [Front Page](#) News 'Sew Challenging'

Day 18 Sew Product Presentations

Assessment:

- Fused Front page News
- [Simple Lifestyle Roundtable](#)
- Sew Challenging Product and Front Page News
- Bad Packaging reflection
- [Participation Rubric](#)

Unit 3: How Does Nature Engineer Solutions?

We are going to address engineering design problems by mimicking Nature. We'll make connections between sustainable design solutions in Nature and human-design problems. We'll explore specific solutions from designers in a variety of fields. Then we'll mimic a specific Nature-design feature to devise a new solution to an everyday problem.

<p>Enduring Understanding:</p>	<p>Living organisms have spent millions of years evolving, to solve and thrive through every 'problem' encountered in their environment. The natural world thrives without overexploiting or polluting. We can learn from nature to engineer eco-friendly solutions to society's problems. We will explore adaptations, or engineering methods, of nature. Life forms on our planet have evolved over millenia to be successful in any environment. Nature can adapt to changing conditions, be resource-efficient, use life-friendly chemistry.</p>
<p>Essential Questions:</p>	<ol style="list-style-type: none"> 1. <i>Why is it beneficial to use biomimicry to solve an engineering problem?</i> 2. <i>How do engineers dissect Nature's designs in order to solve problems?</i> 3. <i>How can I utilize nature's solutions to solve any problem?</i>
<p>MA Frameworks <i>HS-ETS1-1. Analyze a major global challenge to specify a design problem that can be improved.</i> <i>HS-ETS1-2. Break a complex real-world problem into smaller, more manageable problems that each can be solved using scientific and engineering principles.</i> <i>HS-ETS1-3. Evaluate a solution to a real-world problem based on safety, reliability, aesthetics, and environmental impacts.</i></p>	<p>Unit Objectives:</p> <ol style="list-style-type: none"> 1. Appraise ways engineers currently use nature to design new products <i>HS-ETS1-1</i> 2. Deconstruct and evaluate a natural phenomenon, or an organism's adaptation, and apply it to an engineering problem (<i>HS-ETS1-2</i>) 3. Develop a solution to an engineering problem by using biomimicry (<i>HS-ETS1-3</i>)
<p>Assessment Activities:</p>	<ul style="list-style-type: none"> ● Biomimicry Matching Game ● Nature-Inspired Fridge Challenge ● Web Site Project - Link to student web site) ● Nature-inspired Marketing Card Game ● Windmill Challenge
<p>Vocabulary:</p>	<p>biomimicry, thermoregulation, Convection, Sequester, High Tensile Steel, Turbine</p>

<p>Common Activities:</p>	<p>Unit 3: How Does Nature Engineer Solutions?</p> <ul style="list-style-type: none"> ● Biomimicry Notes ● Rapid Design Challenge ● Biomimicry Matching Game ● Watch Videos on biomimicry ● Nature-Inspired Fridge Challenge ● Nature- Inspired research Presentation- Or Nature-inspired web page? <ul style="list-style-type: none"> ○ Link to Student web Site ● Matching Game Design Challenge ● Matching Card Game Design sign-up ● Design Challenge
<p>Project Based Learning Activities:</p>	<ul style="list-style-type: none"> ● Nature-Inspired Fridge Challenge ● Nature- Inspired research Presentation- Or Nature-inspired web page? ● Matching Game Design ● Design Challenge
<p>Resources</p>	<p>Unit Notes TryEngineering Biometrics Architecture The Centre for Biomimetics Ask Nature European Patent Office Search U.S. Patent and Trademark Office National Science Education Standards ITEA Standards for Technological Literacy</p>

Unit 3: How Does Nature Engineer Solutions?

Instructional Strategies: Timeline for completion: 9 Days

Day 1 - Watch 'Waste = Food' video (40 min): ['WASTE = FOOD' Link](#)

Waste=Food [Discussion questions](#)

How does nature solve problems?

- *What are some examples of natural engineering in my own community?*
- [Rapid Design Challenge](#)
- [Biomimicry Notes](#)
- HW: Carbon Footprint challenge

Day 2 How can we be inspired by nature?

- Watch Videos
 - [Ted Talks Awesome Video](#)
- [Biomimicry Matching Game](#)
- [Matching Game Design Challenge](#)
- [Matching Card Design](#) sign-up

Day 3 *How do humans use Nature's designs in order to solve problems?*

- [Nature-Inspired Fridge Challenge](#) and presentations
- HW: Design Challenge brainstorm and illustration

Day 4

- Play Student-designed Matching Game
- Challenge: Brainstorm a nature inspired solution to a problem

Day 5-7

- Design Challenge

Day 8

- Wrap-up Challenge

Day 9

- Front Page News

Extension: [Nature- Inspired student research Presentation](#) [Or Nature-inspired web page?](#)

- [Link to Student web Site](#)

Formative and summative assessment:

- Tray of Nature product
- [Nature-Inspired Fridge Challenge](#)
- [Nature-inspired Marketing Card Game](#)
- Design Challenge
- Front Page News

Unit 4: DIY FINAL Repurpose Build

The final challenge in this course provides the Green engineer the opportunity to design and build a new eco-friendly product of their choice. The criteria requires that the new product be made from waste stream materials with minimal adhesives or other toxic components.

Enduring Understanding:	<ul style="list-style-type: none"> • One person’s trash is another person’s treasure. • Each individual is responsible for making our planet a healthier place. • Anyone can be an engineer.
Essential Questions:	<ul style="list-style-type: none"> • Why are some materials dangerous to the environment? • How can one green engineer make a difference? • Why is failure a part of success?
<p><i>HS-ETS1-1. Analyze a major global challenge to specify a design problem that can be improved.</i></p> <p><i>HS-ETS1-2. Break a complex real-world problem into smaller, more manageable problems that each can be solved using scientific and engineering principles.</i></p> <p><i>HS-ETS1-3. Evaluate a solution to a complex real-world problem based on cost, safety, reliability, aesthetics, and maintenance, social, cultural, and environmental impacts.</i></p>	<p>Unit Objectives:</p> <ol style="list-style-type: none"> 1. Engineers will evaluate the impacts of a real world waste stream problem of their choice. <i>HS-ETS1-1</i> 2. Using the green engineering design process, engineers will create a new product out of materials that typically enter the waste stream. <i>HS-ETS1-2</i> 3. Engineers will communicate the design challenge and benefits of their new product. <i>HS-ETS1-3</i>
Assessment Activities:	<ul style="list-style-type: none"> • DIY Brainstorm presentation • Participation • DIY Build and Infomercial or Front Page News
Common Learning Activities/Labs:	<p>‘Make’ Project</p> <p>Prebuild Brainstorm</p>
Project-Based Activities:	<p>DIY Build</p>

Unit 5: DIY FINAL Build

Instructional Strategies for Unit and Timeline: 12 Days

The engineers will first itemize a list of materials or products that are typically thrown away. Engineers will next brainstorm ideas to make that 'trash' into something artfully useful. Then, each engineer will implement the construction of one idea, research its negative impact as a waste stream item, and finally promote the new product in a front page news article.

Day 1:

Make a list of trash items. ([Day 1 Notes -Instructions](#))

[INstructions for Final](#)

- [Rubric for DIY Final](#)
- Brainstorm new DIY products (shared presentation of products)
- HW: Compare two products you would be interested in building. Choose one and give reasoning with itemized list of materials needed.

Day 2:

- Review front page news criteria
- Submit design for approval on final build. Draw up daily journal plan with template and illustration of completed product. Conduct research on how the 'trash' materials negatively impact ecosystems and health.
- HW: collect and bring in materials/supplies needed for build

Day 3-9:

- Work on prototype and product, journal, check-in's, research for News story
- Feedback Loop

Day 10

- Front page News

Day 11

- Peer Edit

Day 12

- Exam day- Presentations

Assessment :

- [INstructions for Final](#)
- [DIY Build and Infomercial](#)
- [Rubric for DIY Final](#)