Syllabus

Thinking Like an Engineer

"A good scientist is a person with original ideas. A good engineer is a person who makes a design that works with as few original ideas as possible."
Freeman Dyson

Overview

Engineers are the professionals most closely associated with technology and applied science. They are professional problem-solvers and innovators! In this course bundle students will learn how to think like an innovator by learning how to see the world through the eyes of an Engineer.

Learning Targets

- I can explain and apply the 6 steps of problem-solving.
- I know how to use techniques like the 5 Why's problem identity technique and the "What if" technique.
- I can explain what an idea is and how to have more of them.
- I can explain the real definition of the word "solution."
- I can demonstrate the use of different brain-games to help build my innovative muscle.
- I can identify the 4 poisons to innovation and their cure.
- I can explain the importance of engineering and problem-solving using real-world examples.
- I can explain that there are 14 grand problem-solving challenges that need solutions.
- I can define the following terms: tension, compression, twisting, bending, shearing, torsion, vortices, vortex shedding, aerodynamics, dead load, live load, structural-engineering, girder, truss, friction, potential and kinetic energies, g-force.
- I can give an example of how each of these math subjects is used in engineering: Algebra, Geometry, Calculus, Advanced Calculus, Trigonometry, Probability & Statistics, Physics.
- I can demonstrate the correct use of the following tools: ruler, construction level, 3D design software

Standards - Next Generation Science Standards (NGSS) Engineering Design

Students who demonstrate understanding can:

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-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

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 as well as possible social, cultural, and environmental impacts.

HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Materials Needed

(Having difficulty finding materials? Click HERE to view our school store)

- Approximately 40 sheets of regular weight printer paper
- Approximately 1 pack of card stock paper (150 sheets)
- Scissors
- Clear tape
- Masking tape
- Small construction level.
    - Click **HERE** for an example
- Water filter challenge:
    - 2 Two liter soda bottles with caps
    - 2 tablespoons of alum (Potassium Aluminum Sulfate)
    - 1 ½ cups fine sand (play sand or beach sand)
    - 1 ½ cups course sand (multipurpose sand)
    - 1 cup small pebbles (aquarium rocks work best)
    - 1 coffee filter (large)
    - 1 rubber band

Course Outline

Unit 1 - Introduction to Engineering

- Lesson 1 – What is engineering?
- Challenge activity – Design the tallest paper tower
- Lesson 2 – Different types of engineers
- Challenge activity – Design a paper structure that can carry the most books
- Engineering in the News!
- Lesson 3 – Engineering clean water
- Challenge activity – build your own water filtration system
- Lesson 4 – 14 Grand engineering challenges of the world

Unit 2 - Introduction to 3D Computer Design and Solid Modeling

- Lesson 1 – How to get ideas out of your head (Tools of modern design and innovation)
- Lesson 2 - Introduction to 3D design
- Lesson 3 – Introduction to your software
- Lesson 4 – Creating your first sketch
- Lesson 5 - Creating your first 3D object
- Lesson 6 - Practice making shapes
- Lesson 7 - Practice dimensioning (cube-in-a-cube)
- Lesson 8 - Advanced help

- Challenge activity - Let's make a car rim
- Challenge activity - Your own innovations
- Lesson 9 - Rapid prototyping
- Lesson 10 - Advanced challenges (assemblies)
- Challenge activity - Design a fidget spinner
- Lesson 11 – Material properties

Unit 3 - Orthographic Projection

- Lesson 1 – What is orthographic projection
- Lesson 2 - Let's practice!
- Challenge activity

Unit 4 - Engineering Rollercoasters

- Lesson 1 – Types of roller coasters
- Lesson 2 – Roller coaster design
- Lesson 3 – Energy and a little math
- Lesson 4 – Roller coaster construction
- Engineering in the News!
- Lesson 5 – How to become a roller coaster engineer
- Challenge activity – Build a paper roller coaster

Unit 5 - Engineering Bridges

- Lesson 1 – An engineering mystery that stunned the world!
- Lesson 2- 5 types of bridges
- Lesson 3 – Parts of a suspension bridge
- Lesson 4 – How to build a suspension bridge
- Challenge activity – Build and test your own suspension bridges
- Engineering in the News!
- Lesson 5 – Bridges and physics
- Lesson 6 – Famous (and scariest) bridges in the world
- Lesson 7 – Structural engineering (and a little math)
- Lesson 8 – Testing the wind (gathering clues)
- Challenge activity – Build your own wind tunnel and test your own model bridge sections.
- Engineering in the News!
- Lesson 9 – What really happened that day
- Lesson 10 – Out with the old, in with the new
- Lesson 11 – What engineers have learned
- 3D challenge – Bridge design software

Unit 6 - Nano-Engineering

- Lesson 1 – How we see small things
- Lesson 2 – The discovery of a new world!
- Lesson 3 – What is Nano-Engineering?
- Engineering in the News!

Summary - What do I do now?

- Links for additional research in the world of engineering
- High school offerings and career pathways

BONUS COURSE - Thinking Like an Innovator

- “First day of class” welcome and course orientation
- Lesson 1 – The 6 steps of innovation (A tragedy at sea)
- Lesson 2 – What is a problem?
- Lesson 3 – What is an idea?
- Challenge activity – Brainstorming!
- Lesson 4 – How to create more ideas
- Lesson 5 – Brain Games!
- Challenge activity – Mental fitness
- Lesson 6 – 4 Poisons to innovators
- Lesson 7 – The secret ingredient
- Lesson 8 – How to make money!
- Challenge activity – Solo cup
- Lesson 9 – Woman Innovators