
[Fall 2017 – Spring 2018]
[Monday and Wednesday 10:45-12:15]

Middle School Engineering

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Location: The Prometheus Academy

Overview

In this class, students will review simple machines to see how they are used for energy transference in more complex machinery. Students will be using the Engineering Design Process on their many designs throughout the class. Most class activities are hands-on opportunities to test their newly gained knowledge. For example, when learning about criteria and constraints, testing and revision, and brainstorming, they will work together in small groups to create fairly complex Rube Goldberg machines. Additionally, when learning about various forces, they will apply their knowledge to bridge design and construction in order to determine which bridge design is the most robust. During the Spring Semester, students will apply the knowledge gained in class and the Engineering Design Process to build something lasting for the school.

Goals

Students will learn about the following:

- Energy transference and simple machines
- Perspective, orthographic, isometric and CAD drawings
- Tension, compression, torque and shear, how these forces interact with structures, and design basics used when dealing with these forces.
- Various materials and fasteners available, the strengths and weaknesses of each, and how to choose the best material and fasteners for your design.
- Various tools, including basic and power tools, necessary safety instructions, and how/when to use them.
- The Engineering Design Process

Class Evaluation

Because we will be working with many different tools, fasteners and materials the opportunity for possible injury increases dramatically. I will expect exceptional classroom behavior. Students will be asked to leave if they are goofing around, interrupting or not following safety directions while in class. Class participation and conduct will be 50% of their grade. The final grade will be an average of both Fall and Spring Semesters.

Fall Semester:

- 50% Class Participation and Conduct
- 25% Homework
- 25% Class Projects

Spring Semester:

- 50% Class Participation and Conduct
- 25% Homework
- 25% Class Projects

Materials

Please bring the following items to class each day:

- Pencil
- Eraser (separate from the pencil)

Important Dates

Labor Day – Prometheus Closed

[September 4th]

Fall Break – Prometheus Closed

[November 20th – November 24th]

Last Engineering Class –

Fall Semester

[December 11th]

Winter Break – Prometheus Closed

[December 15th – January 14th]

Spring Semester – Classes Resume

[January 15th – January 19th]

Spring Break – Prometheus Closed

[March 12th – March 16th]

Last Engineering class –

Spring Semester

[May 14th]

Summer Break – Prometheus Closed

[May 18th]

Books Used

Making Things Move: DIY Mechanisms for Inventors, Hobbyists and Artists by Dustyn Roberts

Exploring Design, Technology, and Engineering by R. Thomas Wright and Ryan A. Brown

Technology: Engineering Our World by John B. Gradwell and Malcolm Welch

Class Policies

- It is in the student's best interest to avoid absences. Missing more than 3 classes may make it difficult for the student to follow the material. If the student has multiple absences, and he or she is struggling in class, a parent-teacher conference may be necessary to determine how to proceed.
- If a class work is missed, I will work with the student and student's parents to arrange a time outside of class to make up the work.
- Please be on time! Late arrivals may cause a student to miss important content or directions.
- No phones or other electronics are allowed in class. If a student chooses to bring such items out during class, the device may be taken away and held until the end of class. It will be the student's responsibility to retrieve it from me after class.
- All homework is due by the due dates listed on the syllabus. All make-up work should be finished and returned the week after receiving it. No work will be accepted after the last day of each semester. Anything not turned in (homework) or not completed (class work) will be ungraded and therefore will receive a zero. I will not accept any unfinished work after the following dates:
 - Fall Semester – December 11, 2017
 - Spring Semester – May 14, 2018
- During class, students must be kind and respectful to others, even if they strongly disagree. They should listen and wait for others to finish talking before offering their perspective. They should avoid talking over each other and wait patiently for their turn to speak. This is especially important when brainstorming ideas as a group.
- **IMPORTANT:** Above all else, safety is the first priority. If a student's conduct is continuously disruptive or dangerous, perhaps they are not ready to participate in this class until their maturity catches up with their interest. It is my goal to help the students retain their interest and motivation for learning about Engineering while keeping them and the other students out of harm's way. Students may be asked to leave the class for the day or the remainder of the school year if their behavior potentially interferes with the safety of others.

Fall Semester

- **August 28th**
 - Review *Class Policies*
 - Set up Engineering Notebooks
 - Introduction to Engineering: Simple Machines
 - Reverse Engineering - “Reverse engineering is the process of extracting knowledge or design information from anything man-made.”
 - Handouts: *Introduction to Engineering – Notes*
 - All handouts should be stored in your Engineering Notebook and should be left in the classroom.
- **August 30th**
 - What is energy transference?
 - Newton’s Laws of Motion: short videos demonstrating each
 - The Law of Inertia
 - Force, Mass and Acceleration
 - Action and Reaction
- **September 4th** – Labor Day (Prometheus Closed)
- **September 6th**
 - Levers – First Class Levers and Second Class Levers
 - Class Project – Working with Levers
 - Handouts: *Levers*
- **September 11th**
 - Pulleys – Closed and Open Systems
 - Class Project – Working with Pulleys
 - Handouts: *Pulleys*
- **September 13th**
 - Wheel and Axle
 - Class Project – Working with Wheels and Axles
 - Handouts: *Wheel and Axle*
- **September 18th**
 - Inclined Planes, Wedges and Screws
 - Class Project – Working with Inclined Planes, Wedges and Screws
 - Handouts: *Inclined Planes, Wedges and Screws*
- **September 20th**
 - Gears – Spur Gears and Rack-and-Pinion Gears
 - Class Project – Working with Gears
 - Handouts: *Gears – Spur Gears and Rack-and-Pinion Gears*
- **September 25th**
 - Gears – Bevel Gears, Worm Gears and Planetary Gears
 - Class Project – Working with Gears
 - Handouts: *Bevel Gears, Worm Gears and Planetary Gears*
- **September 27th**
 - Gears – Gear Ratios
 - Class Project – Working with Gear Ratios
 - Handouts: *Gear Ratios*
- **October 2nd**
 - Degrees of Freedom
 - Design Constraints
 - Handouts: *Degrees of Freedom and Minimum Constraint Design*

- **October 4th**
 - The Rube Goldberg Machine: Introduction to The Design Process Using Simple Machines
 - Watch examples of Rube Goldberg Machines
 - Handouts: *The Rube Goldberg Machine*, *Score Sheet*, and *Building Your Machine*
- **October 11th**
 - Identify the Problem
 - Identify Criteria and Constraints
 - Handouts: *The Engineering Design Process*, *Engineering Design Flow Chart*, *Identifying Problems*, and *The Rube Goldberg Kit*
- **October 9th**
 - Brainstorm
 - Research and Generate Ideas
 - Explore Possibilities
- **October 16th**
 - Movie: *Martian Mega Rover* a National Geographic documentary illustrating criteria and constraints, testing and revision, and brainstorming
- **October 18th**
 - Select an approach for popping the balloon (10th Simple Machine)
 - Develop a Design - Sketches
 - Determine needs for fabrication
- **October 23rd**
 - Select a method for activating the popping mechanism (9th Simple Machine)
 - Develop a Design - Sketches
 - Determine needs for fabrication
- **October 25th**
 - Select a method for activating the previous mechanism (8th Simple Machine)
 - Develop a Design - Sketches
 - Determine needs for fabrication
- **October 30th**
 - Select a method for activating the previous mechanism (7th Simple Machine)
 - Develop a Design - Sketches
 - Determine needs for fabrication
- **November 1st**
 - Select a method for activating the previous mechanism (6th Simple Machine)
 - Develop a Design - Sketches
 - Determine needs for fabrication
- **November 6th**
 - Select a method for activating the previous mechanism (5th Simple Machine)
 - Develop a Design - Sketches
 - Determine needs for fabrication
- **November 8th**
 - Select a method for activating the previous mechanism (4th Simple Machine)
 - Develop a Design - Sketches
 - Determine needs for fabrication
- **November 13th**
 - Select a method for activating the previous mechanism (3rd Simple Machine)
 - Develop a Design - Sketches
 - Determine needs for fabrication

- **November 15th**
 - Select a method for activating the previous mechanism (2nd Simple Machine)
 - Develop a Design – Sketches
 - Determine needs for fabrication
- **November 20th – November 24th** – Fall Break (Prometheus Closed)
- **November 27th**
 - Select a method for activating the previous mechanism (1st Simple Machine)
 - Develop a Design - Sketches
 - Determine needs for fabrication
- **November 29th**
 - Test and Evaluate
 - Refine
 - Homework:
 - Study The Design Process and be prepared to communicate the results of your project.
- **December 4th**
 - Test and Evaluate
 - Refine
 - Homework:
 - Study The Design Process and be prepared to communicate the results of your project.
- **December 6th**
 - Test and Evaluate
 - Refine
 - Homework:
 - Study The Design Process and be prepared to communicate the results of your project.
- **December 11th**
 - Test – The Rube Goldberg Machine (Parents are welcome to observe as long as you are aware that it will be standing room only and that you must be very quiet!)
 - Last day of class
 - All ungraded class work should be completed by the end of this class period.
 - Any make-up tests should be completed by the end of the day.
 - I will not accept any unfinished work after this date. Anything not completed will be ungraded and therefore will receive a zero.
- **December 15th – January 14th** - Winter Break (Prometheus Closed)

Spring Semester

- **January 15th**
 - Conveying Ideas – Sketching and Basic Drafting
 - Linear Perspective Drawing
 - One-Point Perspective
 - Handouts: *Linear Perspective Drawing, One-Point Perspective: Boxes, One-Point Perspective: Room, One-Point Perspective: Shapes, and One-Point Perspective: Letters*
 - Homework:
 - Complete *Linear Perspective Drawing, One-Point Perspective: Boxes, One-Point Perspective: Room, One-Point Perspective: Shapes, and One-Point Perspective: Letters* – Due January 17th
- **January 17th**
 - Two-Point Perspective
 - Handouts: *Two-Point Perspective: Boxes, Two-Point Perspective: Dice, Two-Point Perspective: Room, Two-Point Perspective: Buildings, Two-Point Perspective: Letter E, and Two-Point Perspective: Letter M*

- Homework:
 - Complete *Two-Point Perspective: Boxes, Two-Point Perspective: Dice, Two-Point Perspective: Room, Two-Point Perspective: Buildings, Two-Point Perspective: Letter E, and Two-Point Perspective: Letter M* – Due January 22nd
- **January 22nd**
 - Isometric Drawings
 - Isometric LEGO Drawing
 - Handouts: *Isometric Drawing, Exploded Assembly, Plans and Elevations of 3D Objects, Copy Isometrics and Isometric Dot Exercise*
 - Homework:
 - Complete *Plans and Elevations of 3D Objects, Copy Isometrics and Isometric Dot Exercise* – Due January 24th
- **January 24th**
 - Orthographic Drawings - Steps used to create an orthographic projection (Power Point)
 - Orthographic LEGO Drawings
 - Handouts: *Isometric View and Orthographic Projection, Orthographic Drawing, Orthographic Rotation, Orthographic Projection Practice, Matching Shapes #2, Matching Shapes #2, Matching Shapes #3, and Matching Shapes #4*
 - Homework:
 - Complete *Orthographic Projection Practice, Matching Shapes #2, Matching Shapes #2, Matching Shapes #3, and Matching Shapes #4* – Due January 29th
- **January 29th**
 - Isometric projection to orthographic projection
 - Handouts: *Orthographic Projection: Problem Sheet 1, and Isometric to Orthographic: Problem Sheet 2*
 - Homework:
 - *Orthographic Projection: Problem Sheet 1, and Isometric to Orthographic: Problem Sheet 2* – Due January 31st
- **January 31st**
 - Isometric projection to orthographic projection
 - Handouts: *Isometric to Orthographic: Problem Sheet 3, Isometric to Orthographic: Problem Sheet 4, and Isometric to Orthographic: Problem Sheet 5*
 - Homework:
 - *Isometric to Orthographic: Problem Sheet 3, Isometric to Orthographic: Problem Sheet 4, and Isometric to Orthographic: Problem Sheet 5* – Due February 5th
- **February 5th**
 - Line Standards (Power Point)
 - Line standard practice
 - Handouts: *Line Standards: Sheet 1 and Line Standards: Sheet 2*
- **February 7th**
 - Orthographic to isometric projection
 - Handouts: *Orthographic to Isometric: Problem Sheet 1*
 - Homework:
 - *Orthographic to Isometric: Problem Sheet 1* – Due February 12th
- **February 12th**
 - Orthographic to isometric projection
 - Handout: *Orthographic to Isometric: Problem Sheet 2*
 - Homework:
 - *Orthographic to Isometric: Problem Sheet 2* – Due February 14th
- **February 14th**
 - Digital Creation – CAD Drawings
 - LEGO CAD Creation video
 - Handouts: *Digital Creation and Five of the Best Free CAD Software*

- **February 19th**
 - Straw Bridge Challenge
 - Handout: *Straw Bridge Challenge*
- **February 21st**
 - Complete Straw Bridges
 - Test Straw Bridges
 - Handouts: *Forces: Pushes and Pulls* and *Physics of Bridges: A Balancing Act*
- **February 26th**
 - Tension and Compression Activity
 - Torsion and Shear Activity
 - Testing Structures: Create a Structure
 - Handouts: *Tension and Compression* and *Torsion and Shear*
- **February 28th**
 - The Five Main Bridge Types
 - MIT Bridge Demonstrations
 - Handouts: *Five Bridge Types* and *Truss Bridges*
- **March 5th**
 - Movie: *Big, Bigger, Biggest: Akashi Kaikyō Bridge* a National Geographic documentary reviewing the history of bridges, materials, distances, and forces
- **March 7th**
 - The Straw Bridge Challenge: Repeated
- **March 12th – March 16th** - Spring Break (Prometheus Closed)
- **March 19th**
 - Testing new and improved straw bridges
- **March 21st**
 - Employing the Engineering Design Process: The Big Project
 - *This portion of class time is not exact but the following is what we will attempt to do in the time frame outlined below. I need volunteers to help drive to Home Depot. I also need parents to be aware that this project may go past the last day of Engineering Class and could even extend into the following week. It all depends upon how efficiently the kids work and how well they stay focused on the task at hand.*
 - Identifying the Problem
- **March 26th**
 - Choosing a problem to resolve
 - Identify Criteria and Constraints
- **March 28th**
 - Materials Chapter
 - Handout: *Materials*
- **April 2nd**
 - Tools and Fasteners Chapter
 - Handout: *Tools and Fasteners*
- **April 4th**
 - Proper tool use videos: *See Jane Drill* and others
- **April 9th**
 - Brainstorm Possible Solutions and Generate Ideas as a group
- **April 11th**
 - Research and Explore Possibilities in smaller groups
 - Sketch out ideas and select viable approaches

- **April 16th**
 - Smaller groups present possible approaches
 - Choose a design based on identified criteria and constraints
 - Handout: *Field Trip Permission Slip* which must be signed and returned
- **April 18th**
 - Create Isometric and Orthographic Designs
- **April 23rd**
 - Create a parts list
- **April 25th**
 - Field Trip to Home Depot. I must have written permission slip from parents. If students do not have permission to attend the field trip, they may stay at the school and use Engineering class time to study for other classes.
- **April 30th**
 - Create a work schedule for project
- **May 2nd**
 - Project Build
- **May 7th**
 - Project Build
- **May 9th**
 - Project Build
- **May 14th**
 - Last day of class
 - All ungraded homework should be turned in by the end of this class period.
 - Any make-up tests should be completed by the end of the day.
 - I will not accept any unfinished work after this date. Anything not turned in or completed will be ungraded and therefore will receive a zero.