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[Fall 2017 – Spring 2018]  
[Monday 1:00-2:30]

# LEGO Mechanisms

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Location: The Prometheus Academy

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## Overview

In this class, students will participate in several hands-on learning opportunities, both individually and in groups. The goal of this course is to introduce the principles that make LEGO constructions work, and to show students component mechanisms which they can incorporate into their own designs using LEGO Technic and LEGO Power Functions.

## Goals

Students will learn about the following:

- Simple Machines: levers, pulleys, wheel and axles, gears, inclined planes
- Basic Concepts: speed, torque, power, friction, traction, backlash, efficiency
- Vehicular Concepts: driveshaft, drivetrain, driveline, steering lock, turning radius, FWD, RWD, 4x4, 4WD, and AWD, weight distribution, center of gravity
- Custom Mechanical Solutions: ratchets, differentials, Oldham coupling, Geneva mechanism, universal joints, Sarrus linkage and Scissor linkage
- Strong Connections: why things fall apart, finding weak links, understanding where to reinforce, reinforced worm gear casings, load-bearing structures

## Class Evaluation

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% Class Projects
- 25% Individual Projects

Spring Semester:

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

## Materials

Please bring the following items to class each day:

- Pencil with eraser

## Important Dates

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**Labor Day – Prometheus Closed**

[September 4<sup>th</sup>]

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**Fall Break – Prometheus Closed**

[November 20<sup>th</sup> – November 24<sup>th</sup>]

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**Last LEGO Class - Fall Semester**

[December 11<sup>th</sup>]

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**Winter Break – Prometheus Closed**

[December 15<sup>th</sup> – January 14<sup>th</sup>]

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**Spring Semester – Classes Resume**

[January 15<sup>th</sup> – January 19<sup>th</sup>]

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**Spring Break – Prometheus Closed**

[March 12<sup>th</sup> – March 16<sup>th</sup>]

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**Last LEGO class – Spring Semester**

[May 14<sup>th</sup>]

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**Summer Break – Prometheus Closed**

[May 16<sup>th</sup>]

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## Books Used

[*The Unofficial LEGO Technic Builder's Guide* by Paweł "Sariel" Kmieć]

[*The LEGO Technic Idea Book: Simple Machines* Yoshihito Isogawa]

*The LEGO Technic Idea Book: Fantastic Contraptions* by Yoshihito Isogawa

*The LEGO Technic Idea Book: Wheeled Wonders* by Yoshihito Isogawa

# 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 is struggling in class, a parent-teacher conference may be necessary to determine how to proceed.
- 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 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 completed 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.
- 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.

**IMPORTANT:** Please, leave your LEGOs at home. Unless prior arrangements have been made between the parent and teacher about bringing them to class, it will be assumed that all LEGOs found at The Prometheus Academy belong in the LEGO Mechanisms collection. Also, all LEGOs used in the classroom must stay in the classroom.

# Fall Semester

- **August 28<sup>th</sup>**
  - Introduction to LEGO Mechanisms
  - Basic Concepts:
    - Speed
    - Torque
    - Power
    - Friction
    - Traction
    - Backlash
    - Efficiency
- **September 4<sup>th</sup>** – Labor Day (Prometheus Closed)
- **September 11<sup>th</sup>**
  - Vehicular concepts:
    - Driveshaft
    - Drivetrain
    - Driveline
    - Steering lock
    - Turning radius
    - FWD, RWD, 4x4, 4WD, and AWD
    - Weight distribution
    - Center of gravity
- **September 18<sup>th</sup>**
  - Basic Units and Pieces:
    - The Technic brick
    - Pins, for joining and rotating
    - Beams, the stud-less alternative
    - The half stud as the minimum building unit
    - Two tricks for building with half studs
- **September 25<sup>th</sup>**
  - Stud-full Building
    - Reinforcing stud-full constructions
    - Stud-full advantages
    - Stud-full disadvantages
  - Stud-less Building
    - Creating rigid stud-less connections
    - Stud-less Advantages
    - Stud-less Disadvantages
  - Methods for connecting bricks and beams
  - Sample builds
- **October 2<sup>nd</sup>**
  - Axles, Bushes, and Joints
    - Axles
      - Standard axles
      - Modified axles
    - Bushes
      - Half bush
      - Toothed half bush

- Toothed half bush with a cutout
  - Regular bush
  - Bush with a long pin
  - Smooth half bush with a cut out
- **October 9<sup>th</sup>**
  - Universal Joints
  - Sample builds
- **October 16<sup>th</sup>**
  - Gears and Power Transmission Basics
    - Drivers, followers, and idlers
    - Gear ratios
    - Working with gears
    - Sample builds
- **October 23<sup>rd</sup>**
  - Gears and Power Transmission Basics
    - Efficiency and gears
    - Backlash and gears
    - Controlling rotational direction
    - An inventory of gears
    - Sample builds
- **October 30<sup>th</sup>**
  - Chains and Pulleys
    - Chains
    - Pulleys
    - String and pulley systems
    - Sample builds
- **November 6<sup>th</sup>**
  - Simple Pulley Systems
  - Differential Pulley System
  - Power Pulley System
  - Sample builds
- **November 13<sup>th</sup>**
  - Lever
    - 1<sup>st</sup> class
    - 2<sup>nd</sup> class
    - 3<sup>rd</sup> class
  - Sample builds
- **November 20<sup>th</sup> – November 24<sup>th</sup>** - Fall Break (Prometheus Closed)
- **November 27<sup>th</sup>**
  - Individual Project – Four Wheel Drive Vehicle
- **December 4<sup>th</sup>**
  - Individual Project – Four Wheel Drive Vehicle
- **December 11<sup>th</sup>** - Last LEGO class for fall semester
  - Last day of class
    - All ungraded classwork should be completed by the end of this class period.
    - Any make-up work 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 15<sup>th</sup> – January 14<sup>th</sup>** –Winter Break (Prometheus Closed)

# Spring Semester

- **January 15<sup>th</sup>**
  - Linkages
    - Chebyshev Linkage
    - Hoeken's Linkage
    - Pantograph
    - Peaucellier-Lipkin Cell
  - Pantograph Build
- **January 22<sup>nd</sup>**
  - Linkages
    - Sarrus Linkage
    - Scott-Russell Linkage
  - Sarrus Linkage Build
- **January 29<sup>th</sup>**
  - Linkages
    - Scissor Linkage
    - Watt's Linkage
  - Scissor Linkage Build
- **February 5<sup>th</sup>**
  - Cam Mechanisms
  - Cam Mechanisms Build
- **February 12<sup>th</sup>**
  - Ratchets
  - Ratchet Hammer Build
- **February 19<sup>th</sup>**
  - Ratchet Hammer Build
- **February 26<sup>th</sup>**
  - Geneva Mechanisms
  - Geneva Mechanism Build – Click Clock
- **March 5<sup>th</sup>**
  - Geneva Mechanism Build – Click Clock
- **March 12<sup>th</sup> – March 16<sup>th</sup>** –Spring Break (Prometheus Closed)
- **March 19<sup>th</sup>**
  - Oldham Coupling
  - Oldham Coupling Build
  - Determine Individual and Group Projects – Student Led
- **March 26<sup>th</sup>**
  - Individual Class Project
- **April 2<sup>nd</sup>**
  - Individual Class Project
- **April 9<sup>th</sup>**
  - Complete Individual Class Project
- **April 16<sup>th</sup>**
  - Group Class Project – Combining Ideas
- **April 23<sup>rd</sup>**
  - Group Class Project – Combining Ideas
- **April 30<sup>th</sup>**
  - Group Class Project – Combining Ideas

- **May 7<sup>th</sup>**
  - Group Class Project – Combining Ideas
- **May 14<sup>th</sup>**
  - Complete Group Class Project
  - Last day of class
    - All ungraded classwork should be completed by the end of this class period.
    - Any make-up work 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.