2.00AJ / 16.00AJ Exploring Sea, Space, & Earth: Fundamentals of Engineering Design
Spring 2009

Exploring Sea, Space & Earth: FUNdaMENTALs of Engineering Design

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Spring 2009

Professors Alex Techet

With occasional guest appearances from Profs Newman, Kim, Leeb, Dubowski & others TBA…

Lecture 1

Handouts:

1. Syllabus
2. Questionnaire
3. “pre-test” mini-Homework (due Thursday)
4. Lab Safety Handout

Posted on the Website:

1. Learning Objectives
2. Design Notebook Guidelines
3. These Lecture Notes!
4. Other Readings

Teaching Staff

Professor Alexandra Techet

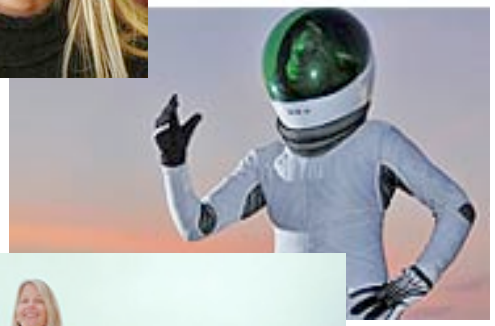
Lectures: Tuesday and Thursday, 2:30 – 4:00 pm
Labs: Wednesday 2 - 5 pm, or Friday 11 am – 2pm
Prereq: 8.01, 18.01 Units: 3-3-3

Prof. Alexandra Techet

- Mechanical & Ocean (course 2/2OE)
- Undergrad Mechanical & Aerospace!
- PhD in Ocean

Prof. Dava Newman

- Aero/Astro (course 16)
- Ugrad Aero, PhD in Aerospace Biomedical Eng.



- Prof. Newman will present guest lectures and the Exploration classes in March!

Lectures & Labs

- Lectures:
  - Tuesday and Thursday, 2:30 – 4:00 pm
- Lab:
  - Wednesday 2 - 5 pm or Friday 11 am – 2pm
- Office Hours:
  - TBA

2.00AJ/16.00AJ 2009 Syllabus *(DRAFT)*

2.00AJ/ 16.00AJ	SP 2009	Prof. Techet	FUNdaMENTALS of Engineering Design		Syllabus	
Lecture	**Day**	**Date**	**Lecture**	**Lecturer(s)**	**Lab Topic**	**CI Req**
1	T	3-Feb	Class Overview. Introduction to Engineering & the Design process, Engineering drawing, sketching, back of the envelope calculations	Techet	LAB #1: Introduction to the OETL Solid Works Tutorial Machine Shop Skills & Safety	**CI Assignments are due tuesdays IN LECTURE for ALL Lab sections (unless otherwise specified)**
2	R	5-Feb	Basic design analysis Free body diagrams, Newton's Laws	Techet		
3	T	10-Feb	Electronics and Water: two great tastes that don't taste so great together… Exploration with Instrumentation	Techet	LAB #2: Light Banks and Solid Works Tutorials/Parts Library	
4	R	12-Feb	The design process	Techet		
	T	17-Feb	NO CLASS (Monday Classes)		LAB #3: Instrumentation Panels Introduction and Construction	Lab Notebook Review #1 (IN LAB)
5	R	19-Feb	Hydrostatics, waterproofing and onboard control/sensors	Techet		
6	T	24-Feb	Propulsion: Power vs. Thrust & Efficiency	Techet	LAB #4: Motor Building and Testing Team development and Brainstorming	Review of a current (major) engineering challenge and why it's important to society today (1-2 pg) (TUESDAY)
7	R	26-Feb	Motors & Electronics (TBA)	Guest/TBA		
8	T	3-Mar	Exploration Adventure part 1 (TBA)	Guest/TBA	LAB #5: Trip to Sailing Pavilion to test instruments Remaining time for vehicle design	Lab Notebook Review #2 (IN LAB)
9	R	5-Mar	Exploration Adventure part 2 (TBA)	Guest/TBA		
10	T	10-Mar	Design Analysis, Error Estimation, Data Presentation	Techet	LAB #6: Design, analysis, Solidworks, parts list, start building	TR #1 Due: Report on Motors and their performance (TUESDAY)
11	R	12-Mar	Communicating Engineering Design Promoting your ideas/inventions	Techet		
12	T	17-Mar	Student Presentations: In-Class Design Review	Students	LAB #7: Build, Revise Analysis, Parts list submission	Team Presentation #1 IN CLASS (TUESDAY) Team presentations posted to STELLAR site (in PDF)
13	R	19-Mar	Design iterations, recalculations	Techet		
	T	24-Mar	NO CLASS (Spring Break)		OETL is closed during break	

Course Overview

- Lectures 2x week
- Lab weekly (2 sessions, must come to assigned session)
- Lecture notes posted ONLINE:
  - All Course Materials can found at the course Website:

- "Homework" and CI assignments are listed in the syllabus

Grading

Overall:		Project:	
Participation	15%	Design	10%
Weekly Design Notebook Review	15%	Does It Work	10%
CI Reports	10%	Data Analysis/Tech Rpts	15%
Oral Presentations	10%	Final Poster Presentation	15%
Total	50%	Total	50%

CI Components

- Individual Communications Requirements
  - ǂ Two ~5 page technical reports
  - ǂ Two CI Reports (2-3 pages)
  - ǂ Design Notebooks
  - ǂ Reflection on course (1pg)
- Team Communications Requirements
  - ǂ Team Preliminary Design Review. Each team will present their team design to the class.
  - ǂ Final Team Presentation. Each team will present their final design, analysis of how the design performed in the competition, and outline their design process in a POSTER session.

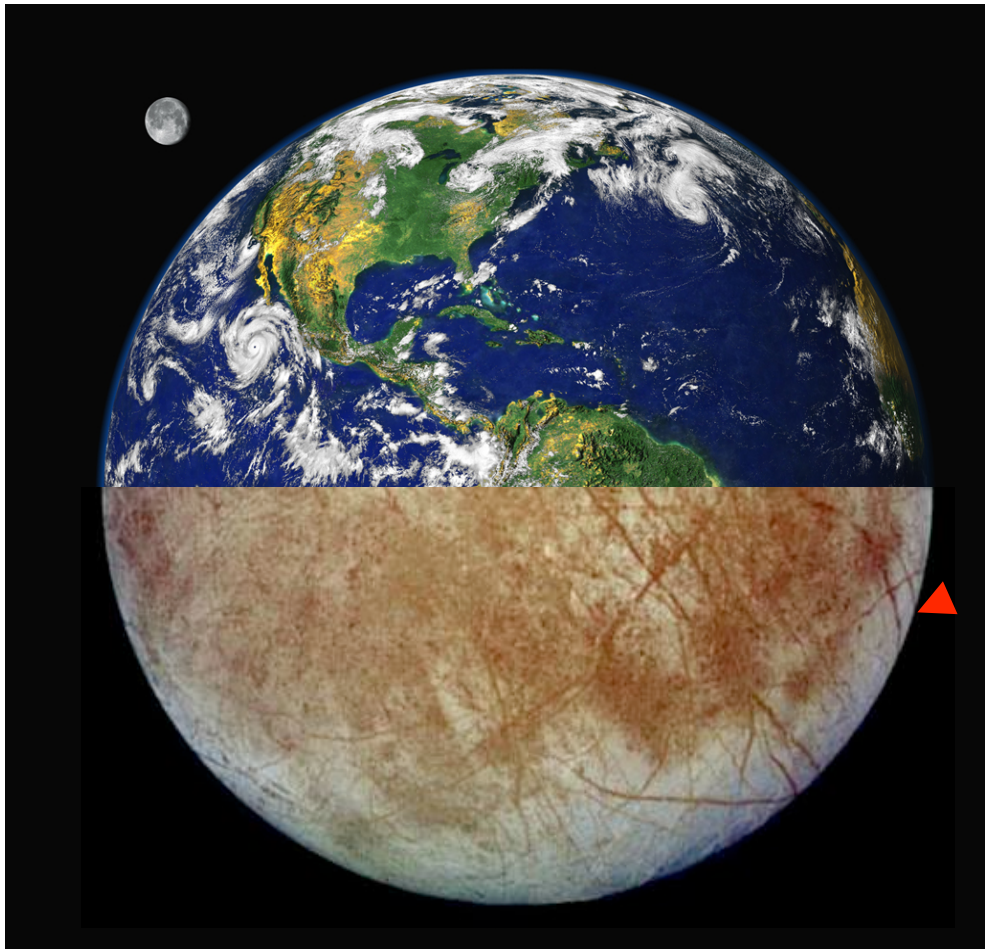
Commitment & Participation

- Students in this class will be expected to participate *fully* in lectures and labs.
- Attendance at weekly labs is mandatory, being late/leaving early/no-shows **will affect your grade.**
- Active participation is also expected in lectures & questions are encouraged
- **Effective "Drop-Date" is March 6th** -- all students will be asked to carefully consider their work load at this time and by staying in the course will have entered into a "contract" that they will not drop after this date (5th week). This ensures that no teams will be left short handed at the last minute!

Exploring Earth, Sea & Space: FUNdaMENTALs of Design

Intro. To Engineering

Earth – Sea – Space



Courtesy of NASA.

- Water covers 71% of the *Earth*.
- The *Oceans* contain 97% of the total water on earth.
- Jupiter's Moon, *Europa*, may be the only place in the solar system besides Earth where liquid water exists in significant quantities.

Water, water everywhere…

Courtesy of NASA.

- The surface area of the Earth is about 510,066,000 km^2,
- Only 29.1% of the Earth is covered by land (148,647,000 km^2)
- The total area of water is 361,419,000 km^2, or 70.9% of the Earth's surface.
- Oceans (salty water) make up 335,258,000 km^2 (97% of total water),
- Only 3% of the water on earth is actually fresh water.

What's the difference between a liquid and a solid?

Image courtesy preef on Flickr.

Image courtesy of Michael Apel on Wikimedia Commons.

What's the difference between a liquid and a solid?

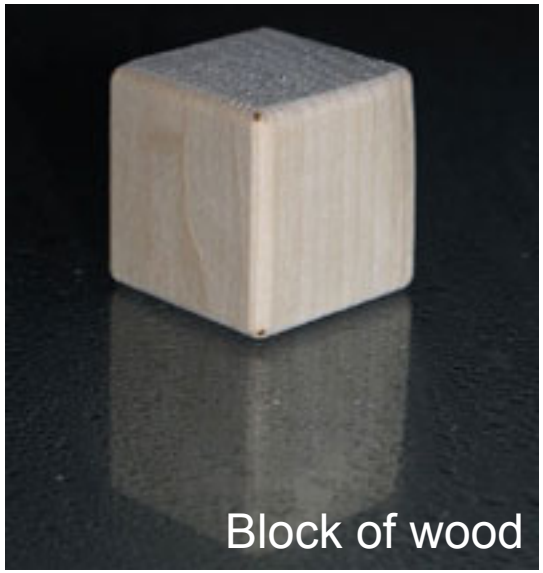


Image courtesy preef on Flickr.

Image courtesy of Michael Apel on Wikimedia Commons.

- Solid will only deform so far under applied forces
- Fluids *at rest* cannot resist shear forces

  (Fluids at rest cannot rest)

Fluids can be either liquids or gases

Courtesy of NASA.

Water & Air

Courtesy of the U.S. Navy.

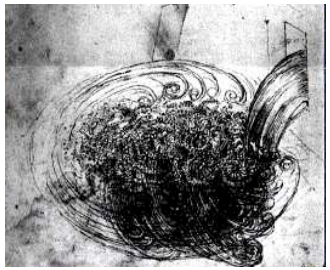


Image by Leonardo da Vinci.

- Hydrodynamics v. Aerodynamics
  - *Water is almost 1000 times denser than air!*

- Air
  - Density

$$\rho = 1.2\, kg/m^3$$

  - Dynamic Viscosity

$$\mu = 1.82\times10^{-5}\, N\cdot s/m^2$$

  - Kinematic Viscosity

$$\nu = \mu/\rho \;\; = 1.51\times10^{-5}\, m^2/s$$

- Water
  - Density

$$\rho = 1025\, kg/m^3 \text{ (seawater)}$$

$$\rho = 1000\, kg/m^3 \text{ (freshwater)}$$

  - Dynamic Viscosity

$$\mu = 1.0\times10^{-3}\, N\cdot s/m^2$$

  - Kinematic Viscosity

$$\nu = 1\times10^{-6}\, m^2/s$$

Fluid Properties @20ºC

What do these three things have in common?

Courtesy of NASA.

Largest Privately Owned Yacht in the World

Image courtesy of Daisuke Ido on Flickr.

Maserati Race Car

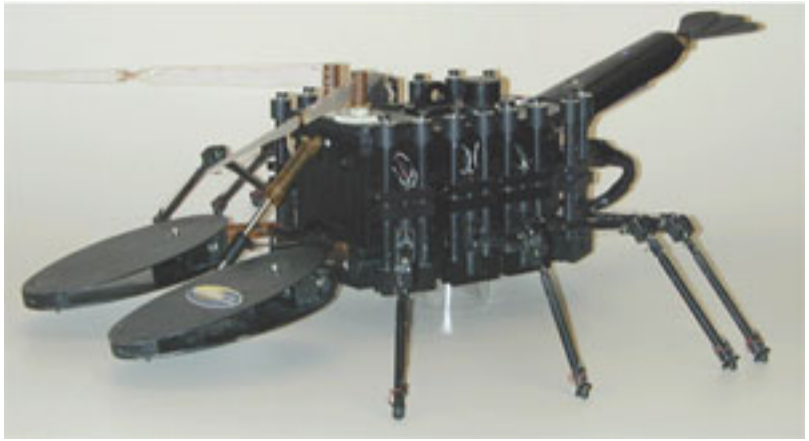
Image courtesy of Mulsanne on Flickr.

These?

Mars Rover

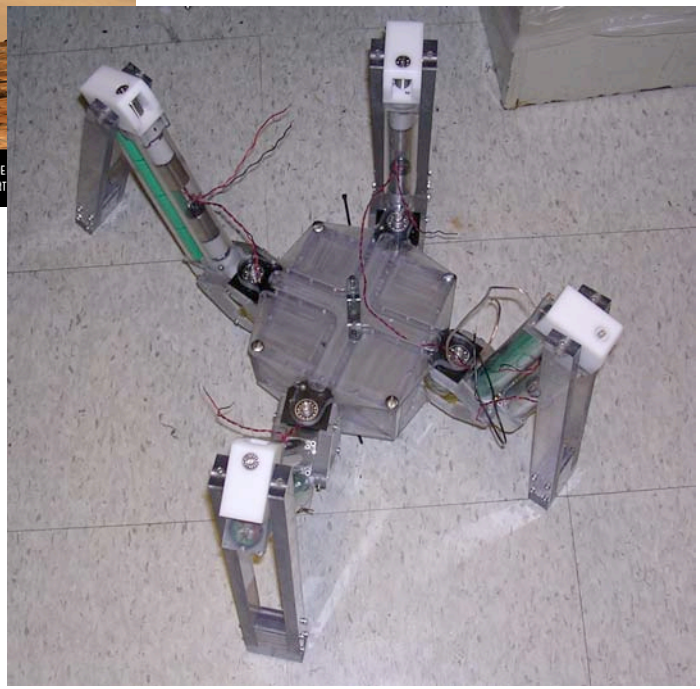
Courtesy of NASA.

Robo Lobster



Courtesy of Joseph Ayers and Jan Witting.
Used with permission.

Amphibious Tetrapod



These?

Image removed due to copyright restrictions.
Please see
http://www.achievement.org/achievers/ear0/large/ear0-004.jpg

Future Warrior Concept

Courtesy U.S. Army.

Sylvia Earle in the *Jim Suit*

Courtesy of NASA.

Shuttle Astronaut

Engineering (roughly)

- **Earth:** Mechanical, Material Science, Chemical, Biological, Nuclear, Electrical, Civil & Environmental
- **Sea:** Ocean, Mechanical, Aero, Electrical, Chemical, Civil & Environmental, Biological
- **Space:** Aero/Astro, Mechanical, Electrical, Ocean, Civil, Biological, Chemical