Statics - TAM 211

Fall 2018

Lecture 1
Overview and General Principles

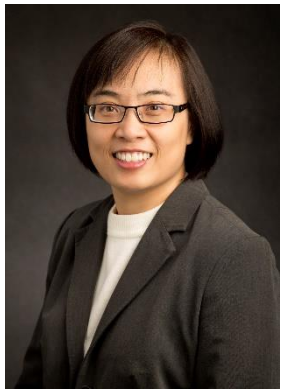
Announcements

- Welcome to TAM 211!
- Pre-lecture slides will be posted by the evening before class on the course website Schedule page https://courses.engr.illinois.edu/tam211/
  - You should download to computer/tablet or print before class to be able to take notes
- Go through course website (policies, info, schedule)

- Upcoming deadlines:
- Will be announced here

TAM 211 ZJUI Team

Instructor



Elizabeth Hsiao-Wecksler, Ph.D. (Xiao-Wecksler)
Professor, Willet Faculty Scholar
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UIUC
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Teaching Assistant

Zhaoyu Xu, MSc
PhD Candidate
College of Civil Engineering and Architecture
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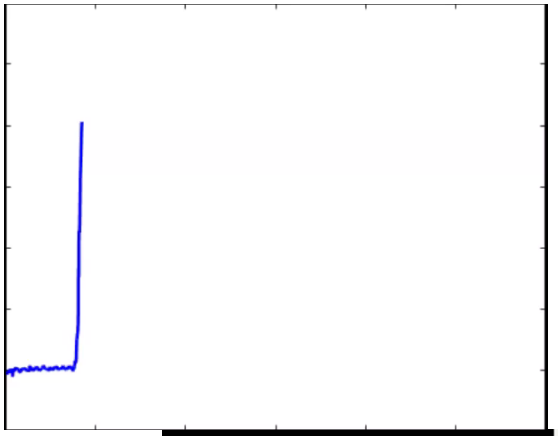
xuzhaoyu@zju.edu.cn

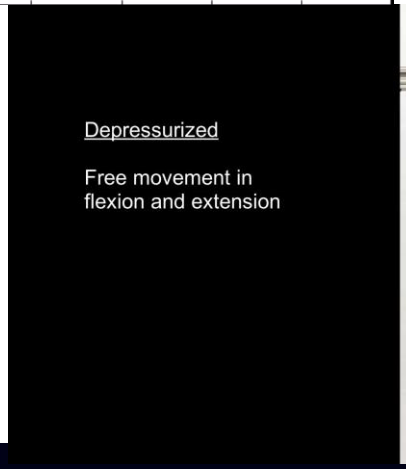
My research

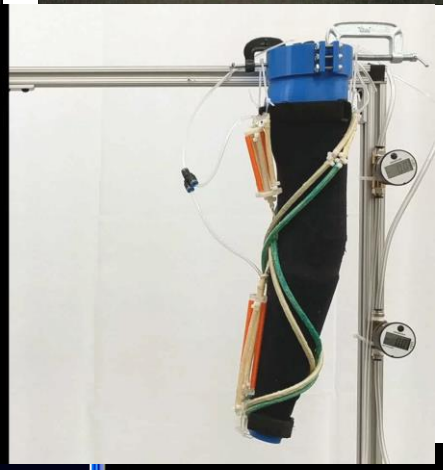
Human Dynamics & Controls Lab

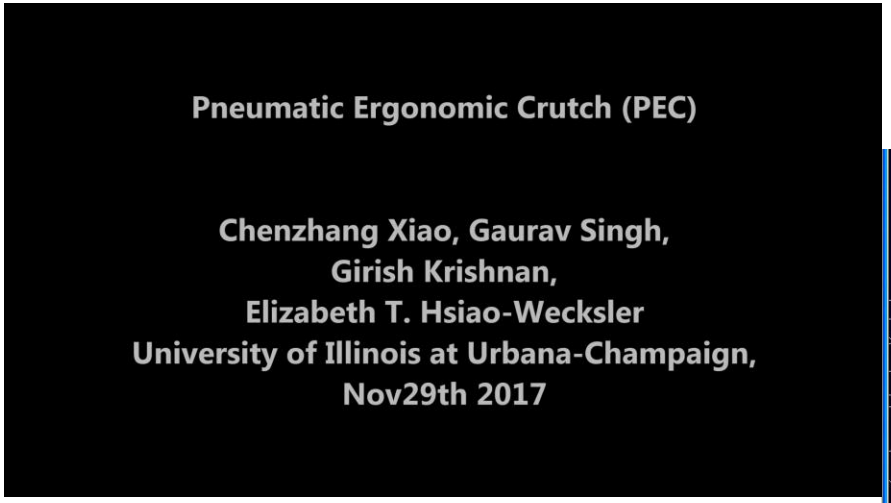


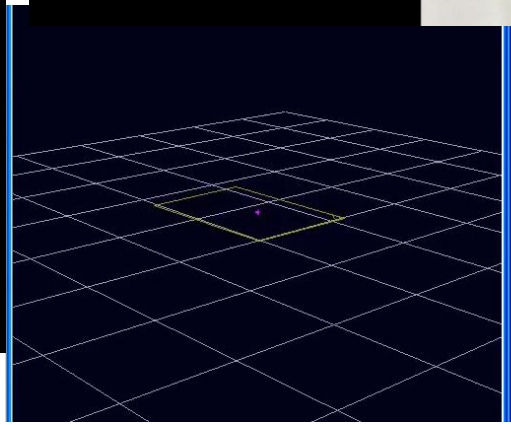
[Elizabeth Hsiao-Wecksler](#)
Professor, MechSE
Associate Head of UG Prog

Assistive device design and ~~control~~
Soft robotics, pneumatic devices, exoskeletons
Locomotion biomechanics – motion capture









My son's at ZJUI

Jack

Doren

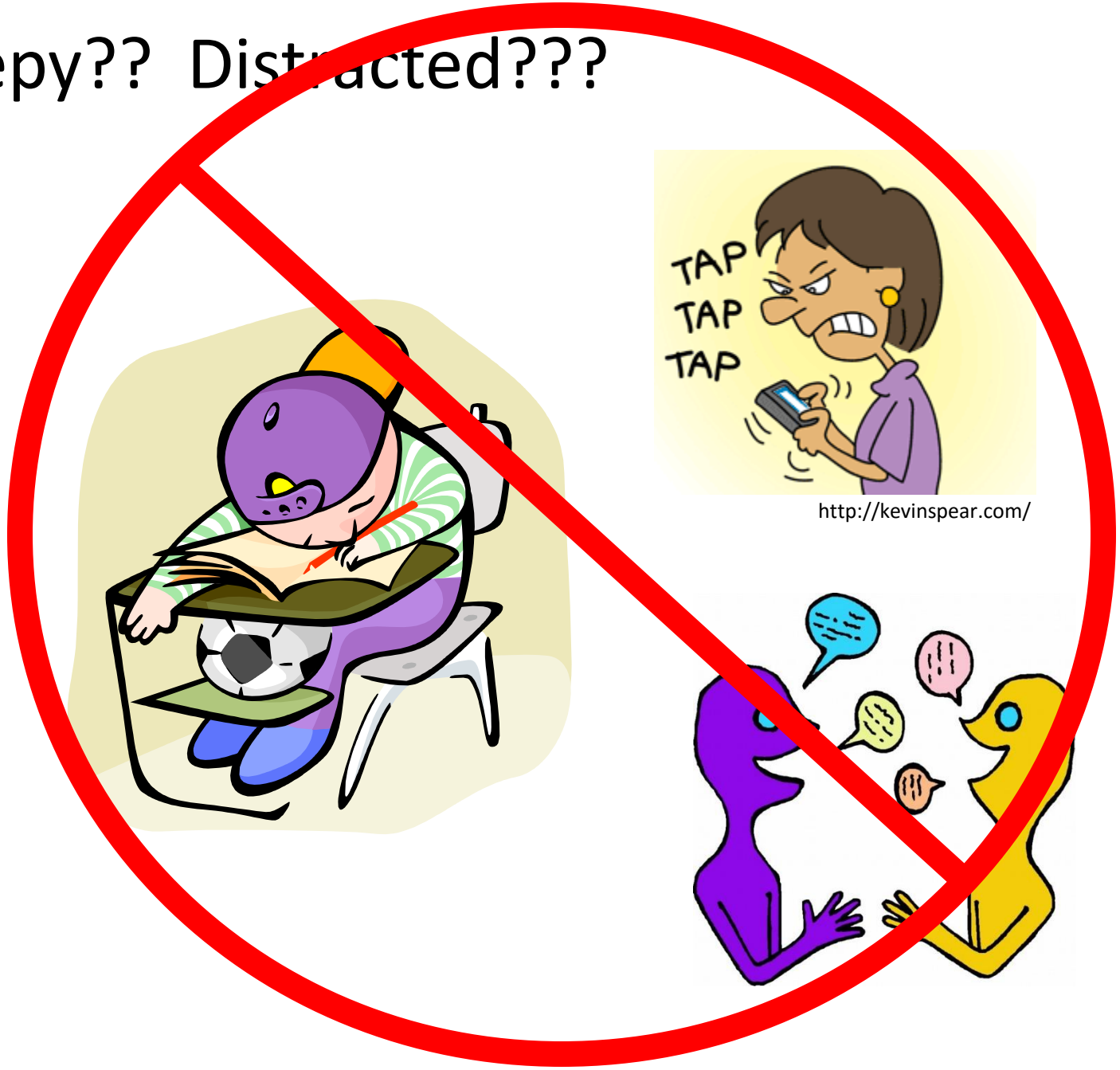
English practice partner/tutor

Rock band enthusiast

Video games

Musicals

Sleepy?? Distracted???



http://kevinspear.com/

Course website

MAIN PAGE - https://courses.engr.illinois.edu/tam211/

ZJUI TAM 211: Statics

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Welcome to the official course website for TAM 211 at ZJUI this Fall 2018.

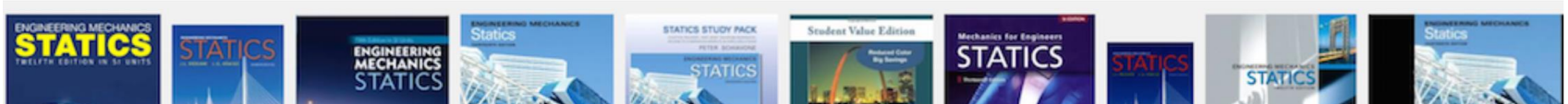
TAM 211 has always been a very difficult transition course for students in their early semesters of college. This course is challenging because students are exposed to multiple online teaching platforms (Prairie Learn, Blackboard, computer-based testing), multiple requirements in terms of frequent homework assignments, written assignments, quizzes, structured worksheets in Discussion sections that require working with a team of people, and the need for good personal time management skills. It is one of the first of many rigorous courses that undergraduate engineering students will experience in their college studies. Our goal as educators is to help our undergraduate students to achieve academic success and graduate as engineers. We train our undergraduate students to learn broad fundamental engineering knowledge that will allow them to have enough background to directly address, or know where to look for answers to address, the technological challenges of today and the future. Engineering is not about memorization; it is about being a problem solver, using one's general knowledge, and applying it to new areas.

The key to succeeding in TAM 211, or any class, is to practice the material **before** the time for assessment (quiz or exam). This course has many opportunities to practice; use them to your advanatge. Ask for help from the instructional staff or your friends (but do not just copy your friends answers - that is not practicing the material).

NOTE: This website is always under construction!! Feel free to peruse, wander, and learn a bit about what's coming up this Fall, but dates/times/assignments etc. are subject to change. If you have any questions, feel free to drop us a line at the discussion forum on Blackboard (see link below).

As well as the pages on this website, this course uses:

- Online homework via PrairieLearn
- Discussion forum on Blackboard
- Gradebook on Blackboard

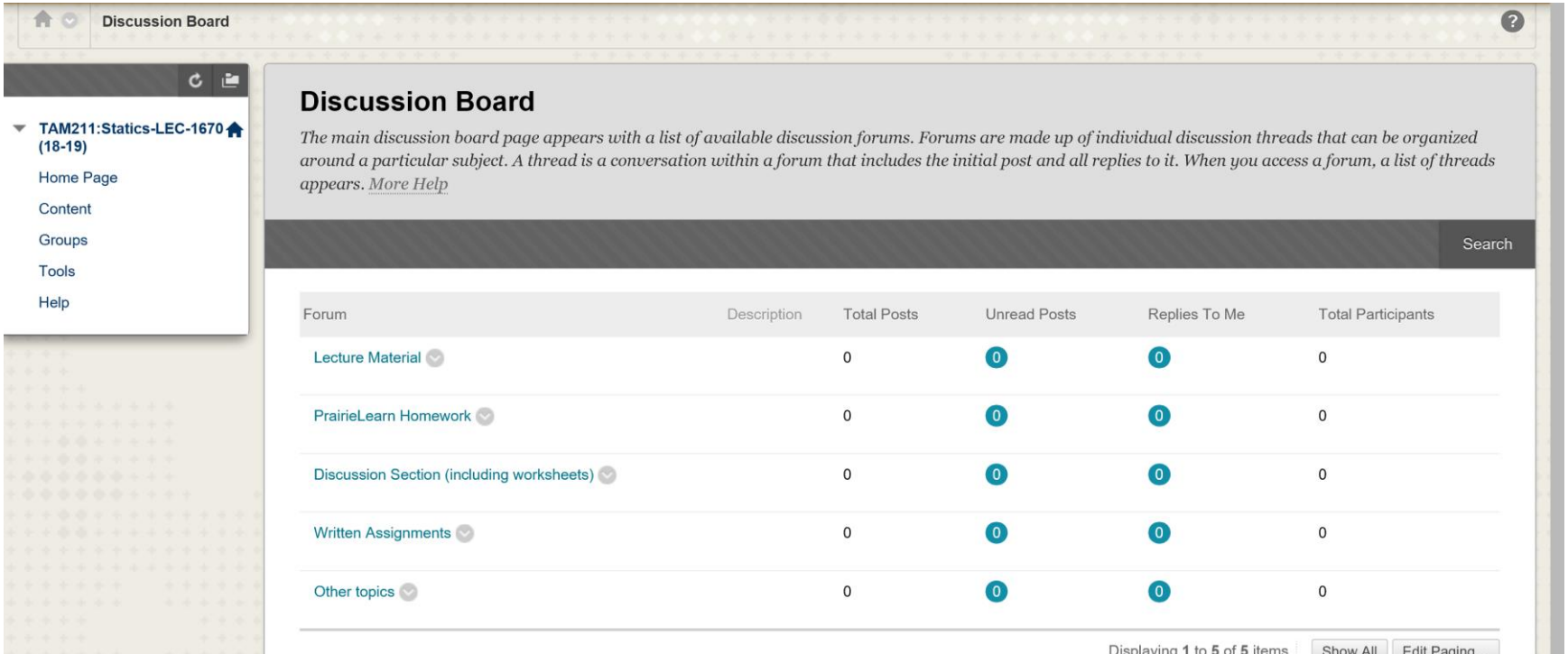


Course communication

Blackboard Discussion Board

ALL communication in the course will be via Blackboard Discussion Board

- Open discussion of questions from class: if there is something you donot understand, chances are other people also have the same question and someone else may have the answer.
- Regularly checked by TA and Prof.



Course format

Learning & Practice

- Read Hibbeler Chapter
- Lectures
- i-Clicker during lecture
- Discussion sections – weekly work sheets [team]
- PraireLearn Online Homework – due weekly [individual]
- Written Assignment (WA) – due every 2 weeks [individual]

Assessment

- Quiz – every 2 weeks (not same week as when WA is due) [individual]
- Final exam

Grade distribution for TAM 211

In class i-Clickers: 3%

Discussion group activity: 12%

Online Homework (PrairieLearn): 10%

Written Assignments: 15%

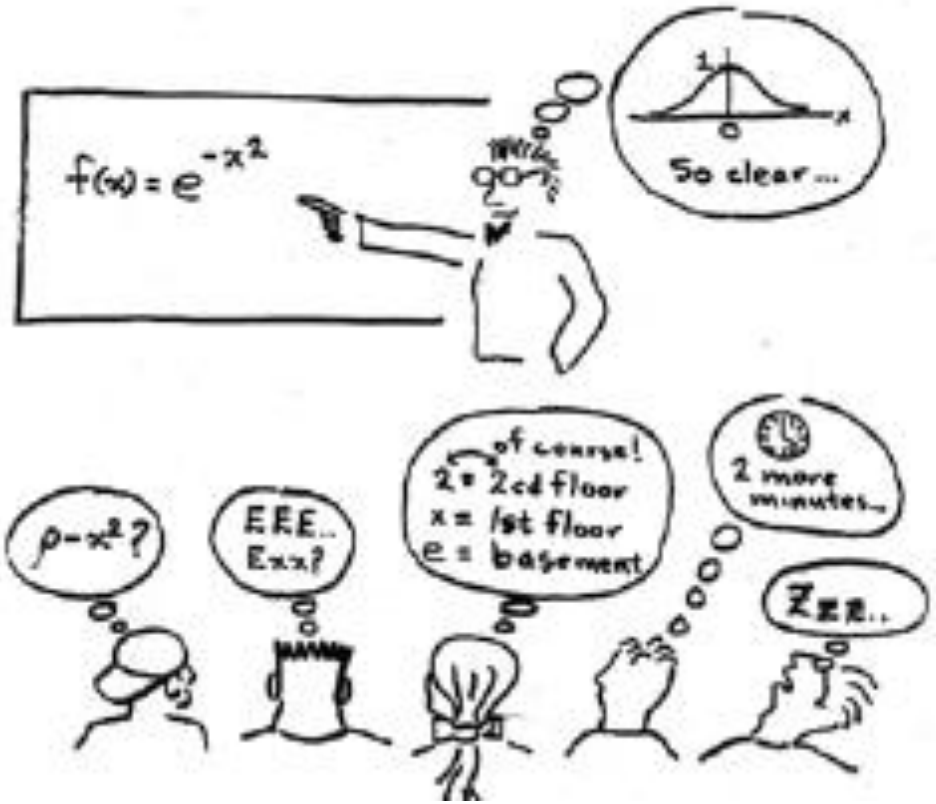
Quizzes: 40%

Final Exam: 20%

i-Clickers (3% of grade)

- Used for in-class assessment
- Attendance, participation, correctness

- Register your i-Clicker (will provide instructions later)



"Make Clickers Work for You"
Dr. Stephanie Chasteen (CU-Boulder)

Discussion group activity – 8% of grade

- Work in groups of 3-4 students
- Goals:
  - **Gain experience in team-work**
  - **Apply engineering concepts learned in lecture to real-world problems or hands-on activities**

dubishere.com

- **Be prompt: if you are more than 5 minutes late, you will receive a 0 ☹**

- You need to attend the discussion in which you are registered, otherwise, your assignment will not be graded

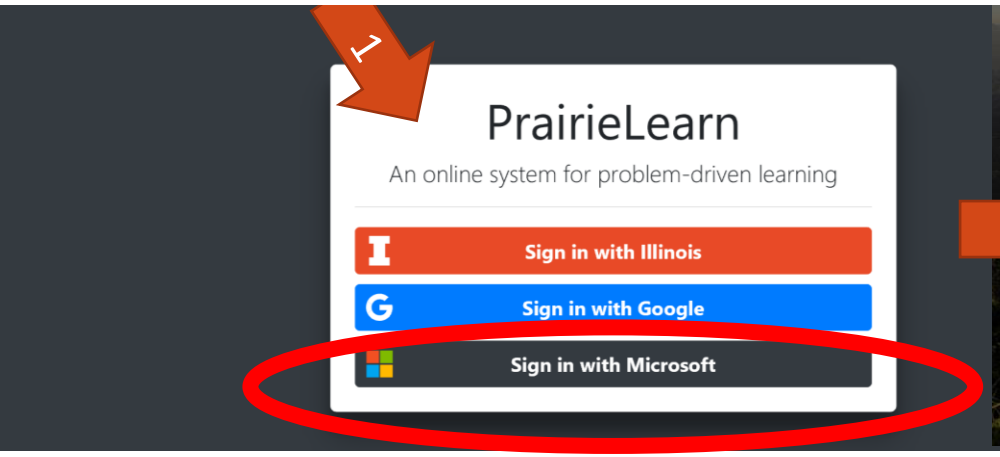
Online Homework in PrairieLearn (10%)

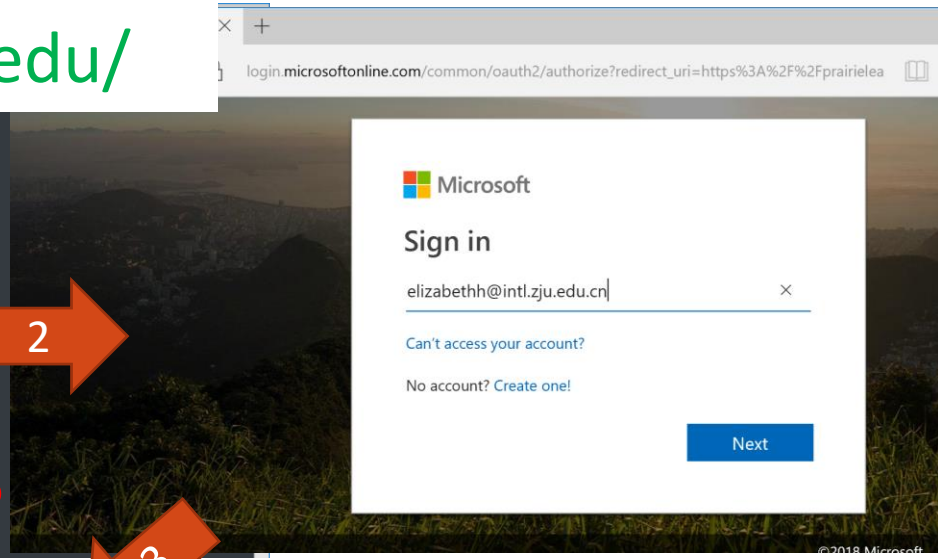
https://prairielearn.engr.illinois.edu/

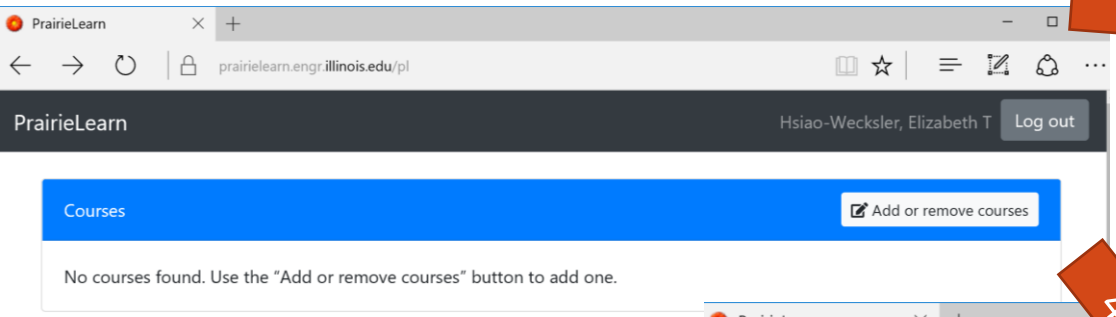
- Provides instant feedback
- Infinite number of attempts to help with learning
- Complete by 11:59 pm of due date

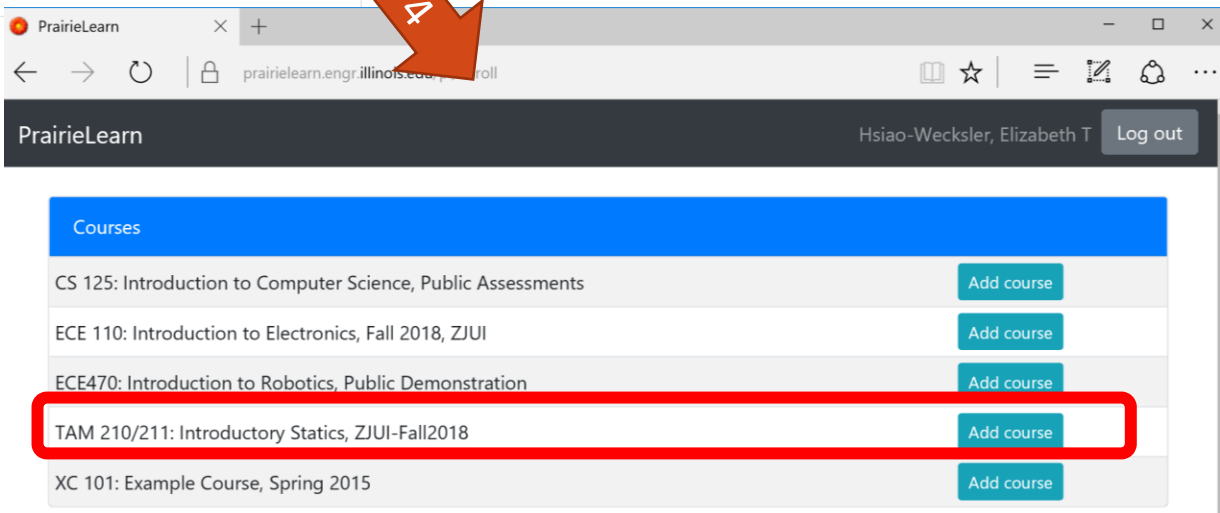
- Not trying to solve problems on your own and copying others answers will make taking quizzes ∞ more difficult!

https://prairielearn.engr.illinois.edu/



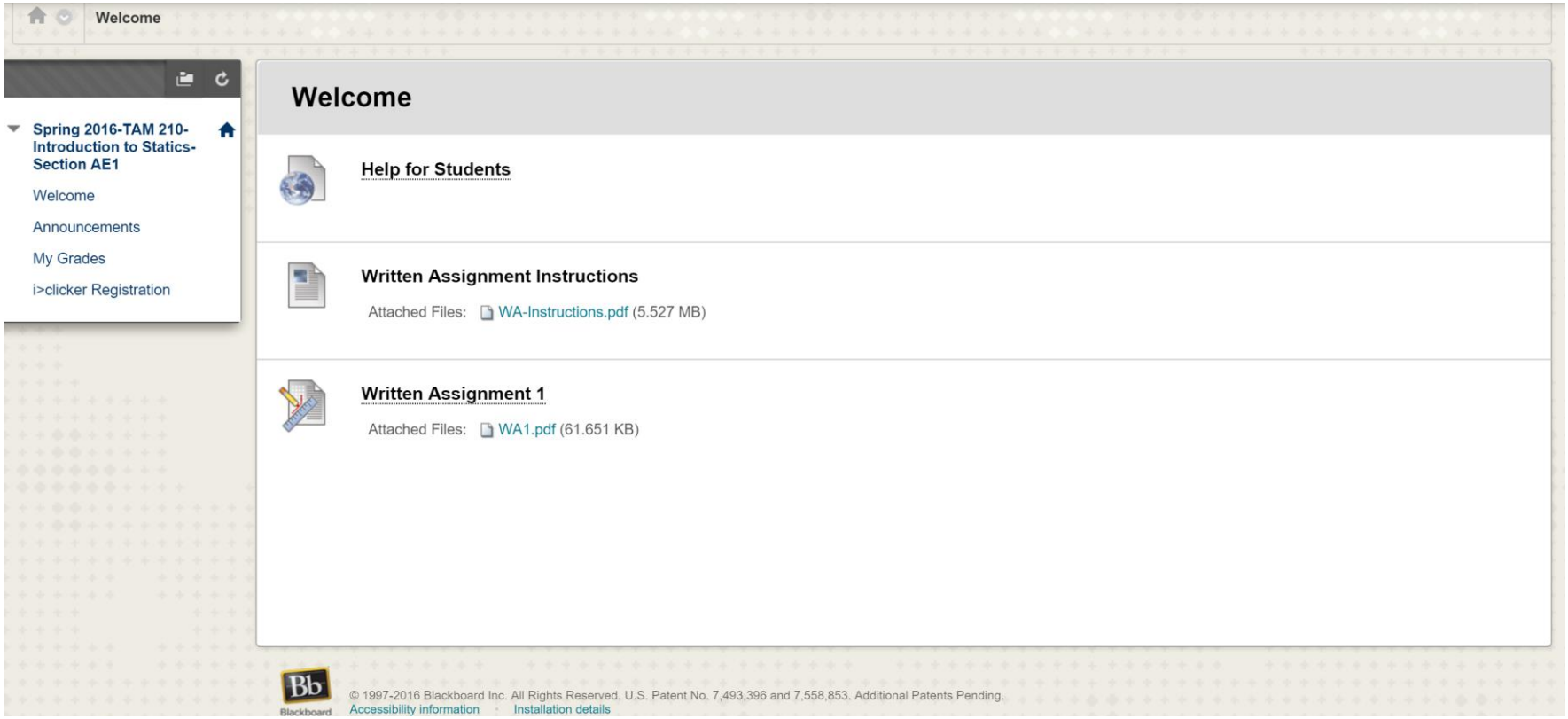






Written Assignments – 15%

- Student will submit an **individual written report using Blackboard**
- Goal:
  - **Practice the communication of engineering concepts in writing**
  - The reports will be graded based on approximately:
    - 40% presentation, neatness, correct use of symbols, quality of drawings and diagrams, and clarity of explanation
    - 60%: Correct interpretation of the problem and correct final answers.



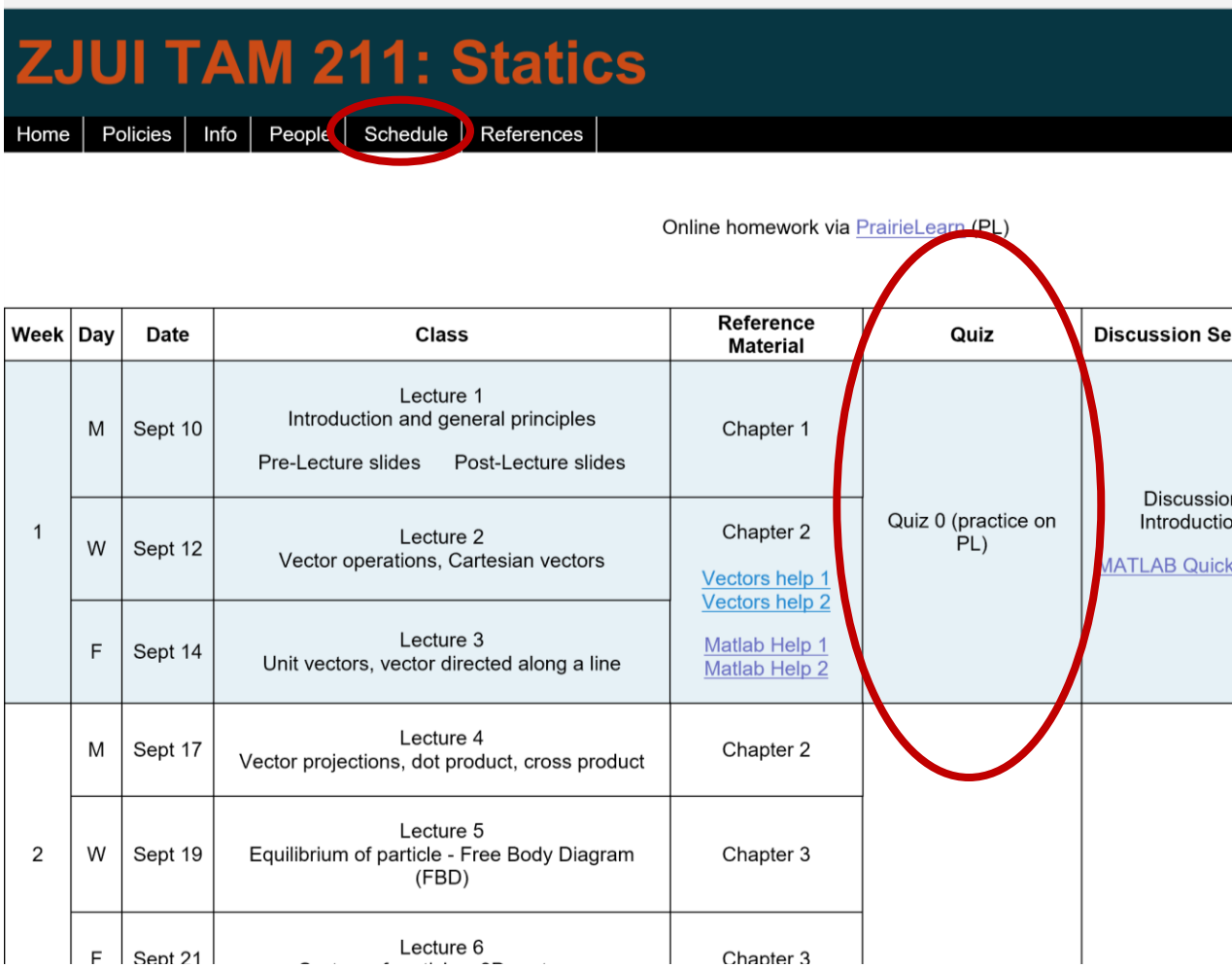
Quizzes - 40%

- Every two weeks (6 quizzes)
- Computer lab
- Check Schedule for dates
- **No personal calculators!**
- ***Be able to use computational software*** **(online calculator on lab computers or MATLAB)**
- Helps you assess your understanding of the material in real time

- Lowest grade is dropped

Quiz 0 (Practicing sample format)

- Familiarize students with online quiz format
  - Max points per question decreases with increasing attempts
  - Finding attached help documents
- Complete in PrairieLearn
  - Not graded



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Online homework via PrairieLearn (PL)

Week	Day	Date	Class	Reference Material	Quiz	Discussion Se
1	M	Sept 10	Lecture 1 Introduction and general principles Pre-Lecture slides Post-Lecture slides	Chapter 1	Quiz 0 (practice on PL)	Discussio Introductio MATLAB Quick
	W	Sept 12	Lecture 2 Vector operations, Cartesian vectors	Chapter 2 Vectors help 1 Vectors help 2		
	F	Sept 14	Lecture 3 Unit vectors, vector directed along a line	Matlab Help 1 Matlab Help 2		
2	M	Sept 17	Lecture 4 Vector projections, dot product, cross product	Chapter 2		
	W	Sept 19	Lecture 5 Equilibrium of particle - Free Body Diagram (FBD)	Chapter 3		
	F	Sept 21	Lecture 6	Chapter 3		

Will be available shortly

Online computational software

- No personal calculators allowed in computer lab
- Need to be able to do calculations during quizzes
- Available options : MATLAB, and *online calculator (TBA)*

- While solving PL HW, practice using one of these online options so you can become efficient.

- Most UIUC COE students know (or will learn) MATLAB
- Course website has MATLAB help documents (References)

- MATLAB training/refresher during Discussion 1

How Many of you know or have used MATLAB? % KNOWLEDGE

A) 0% B) 20% C) 50% D) 75% E) 100%

Exam – 25%

Cumulative final exam

During final exam period (January 2-11)

Grade distribution

Final grades: The total score s corresponds to final grades as follows.

$97\% \le s \le 100\%$	A+	$92\% \le s < 97\%$	A	$89\% \le s < 92\%$	A-
$86\% \le s < 89\%$	B+	$82\% \le s < 86\%$	B	$79\% \le s < 82\%$	B-
$76\% \le s < 79\%$	C+	$72\% \le s < 76\%$	C	$69\% \le s < 72\%$	C-
$66\% \le s < 69\%$	D+	$59\% \le s < 66\%$	D	$55\% \le s < 59\%$	D-
$s < 55\%$	F				

Grades: on Blackboard

- Any errors in grade reporting on Blackboard must be reported within 2 weeks of the due date or by the last day of class, whichever is earlier.
- Missing grade for discussion section, written assignment, online homework, or quiz contact TA
- Missing grade from i>clicker, contact the instructor

Support for students:

- Blackboard Discussion Board posts

- Prof. Hsiao-Wecksler's Office Hours:
  - Time and date TBA (to be announced)
  - ZJUI Building C, Room 315
  - Or by appointment (elizabethh@intl.zju.edu.cn)

- TA Zhaoyu Xu's Office Hours:
  - Friday 13:00-16:00
  - Library Cafe

How to make the most from lecture…

- Attend!
- Use technology - bring your tablets, laptops, etc.
- Traditional technology - Bring paper and pencil/pen
- Participate
  - Ask questions
  - Be prepared to answer questions
  - “I do not know” is ok too!
- Develop good time management skills

- Any questions?

Course Overview

Description: In this course, we will cover fundamental concepts that are used in every engineering discipline. We will begin with forces, moments and move towards structural analyses of frames, devices, and machines. By the end, you will be able to solve rigid body mechanics problems that will inform the design of everything from bridges to biomedical devices.

Big Idea: Clear knowledge of external forces (boundary conditions) is required to determine what constraints are necessary for the safe (static equilibrium) development and design of any widget. Free body diagrams are an essential tool for understanding the forces and moments on a body.

Chapter 1: General Principles
Chapter 2: Force Vectors
Chapter 3: Equilibrium of a particle
Chapter 4: Force System Resultants
Chapter 5: Equilibrium of (2D & 3D) Rigid Bodies
Chapter 6: Structural Analysis
Chapter 7: Internal Forces
Chapter 8: Friction
Chapter 9: Centroids, Fluid Pressure
Chapter 10: Moment of Inertia
Chapter 11: Virtual Work

Chapter 1: General Principles

Chapter 1: General Principles
Main goals and learning objectives

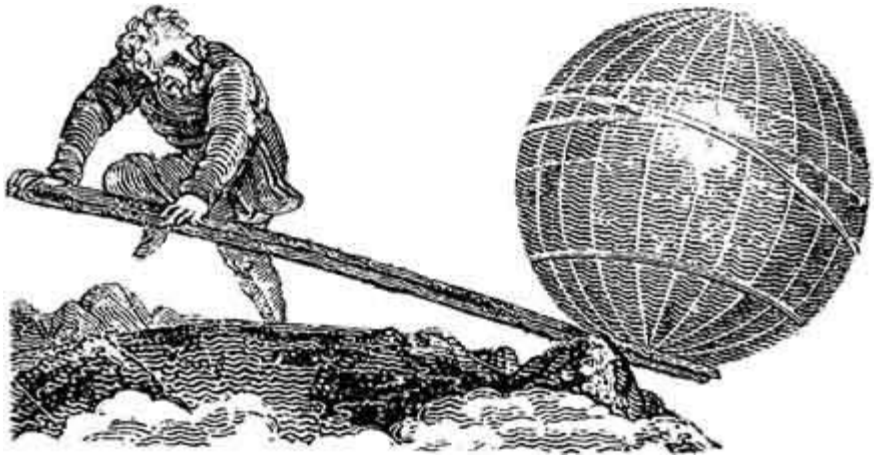
- Introduce the basic ideas of *Mechanics*
- Give a concise statement of Newton's laws of motion and gravitation
- Review the principles for applying the SI system of units
- Examine standard procedures for performing numerical calculations
- Outline a general guide for solving problems

What is “statics”?

- Science
  - Life
  - Physical
    - Astronomy
    - Physics
      - Relativity
      - Mechanics
      - Thermo
      - More!
    - Chemistry
    - More!
  - Social
  - More!

$F = ma$, $a = 0$ ($v = 0$ or $v = \text{const}$), $= 0$

- Mechanics: State of rest or motion of bodies subjected to forces



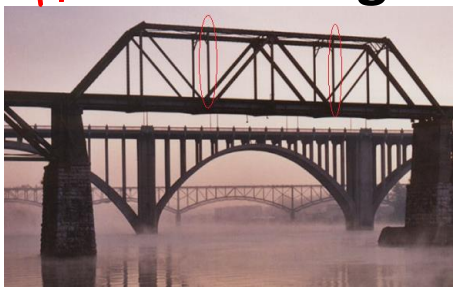
Mechanics

Mechanics is a branch of the physical sciences that is concerned with the **state of rest or motion of bodies that are subjected to the action of forces**

F=0

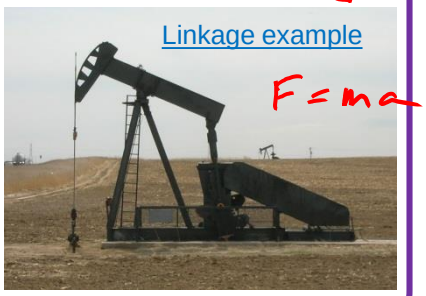
TAM 211

Rigid Bodies TAM 212



Linkage example

F=ma



Statics

Dynamics

Deformable Bodies

Solid Mechanics

TAM 251

CE ME

Fluid TAM 335 / ME 310

Compressible and incompressible

victorstuff.com

Which forces?

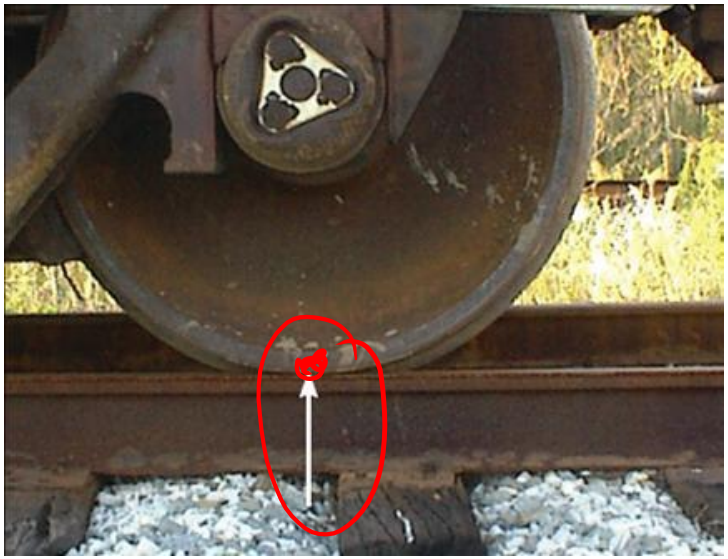
www.ashvegas.com

- Mechanics: State of rest or motion of bodies subjected **to forces**

Fundamental concepts

Basic quantities:

- Mass
- Time
- Length (size)
- Force



Idealizations:

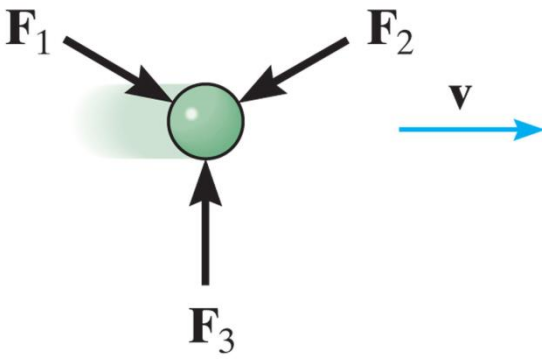
- Particle: Has Mass
  Size is negligible
- Rigid Body: Has Mass & size
  Shape stays the same (no deformation)
- Concentrated Force:
  Force applied @ point

Understanding and applying these things allows for amazing achievements in engineering!

Newton's laws of motion

First law: An object remains at rest or moves with constant velocity in a straight line unless acted upon by a net force.

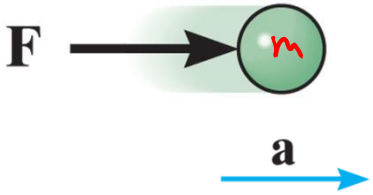
$\Sigma F = 0$



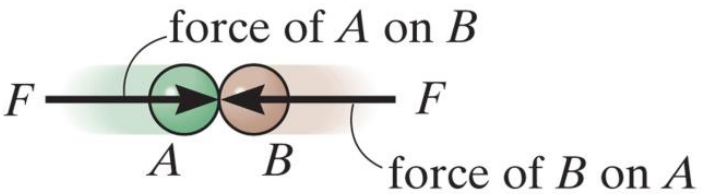
Second law: a particle acted upon by an unbalanced force ***F*** experiences an acceleration ***a*** that is proportional to the particle mass *m*:

$F = ma$

$\Sigma F = \Sigma m_i a_i$



Third law: the mutual forces of action and reaction between two particles are equal, opposite and colinear.



Newton's law of gravitational attraction

The mutual **force F of gravitation** between two particles of mass m_1 and m_2 is given by:

$$F = \frac{G m_1 m_2}{r^2}$$

G is the universal constant of gravitation (small number)
r is the distance between the two particles

Weight is the force exerted by the earth on a particle at the earth's surface:

$$W = F$$

$$W = m\frac{G M_e}{r_e^2} = mg$$

$$\frac{G M_e}{r_e^2} = g$$

$$g = 9.81 \frac{m}{s^2} \text{ or } 32.2 \frac{ft}{s^2}$$

M_e is the mass of the earth
r_e is the distance between the earth's center and the particle near the surface
g is the acceleration due to the gravity

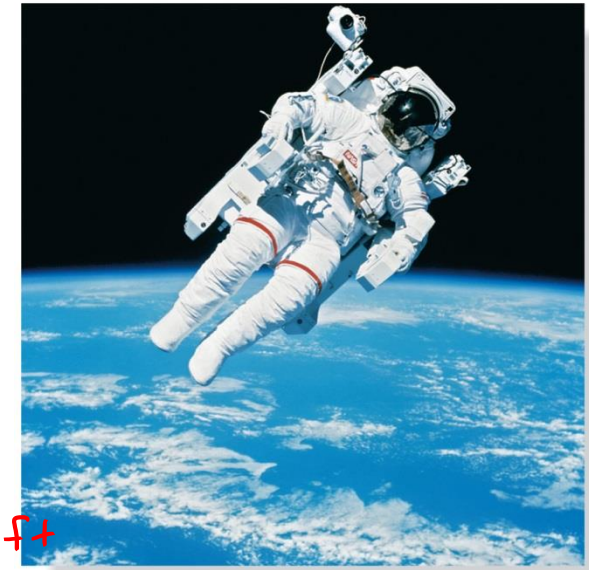


Figure: 01_PH003
The astronaut's weight is diminished, since she is far removed from the gravitational field of the earth.

Units

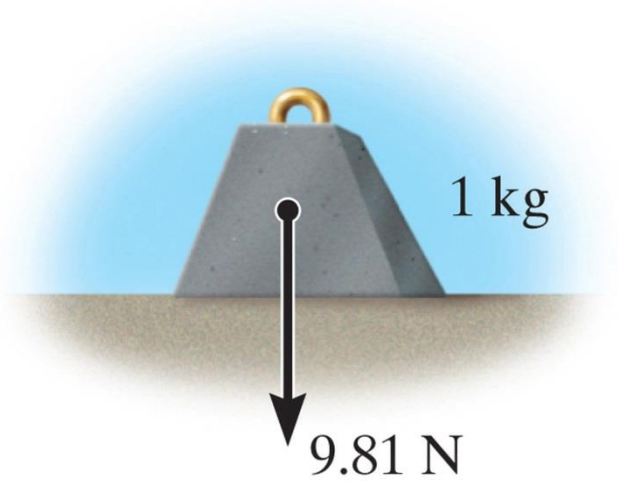
TABLE 1–1 Systems of Units

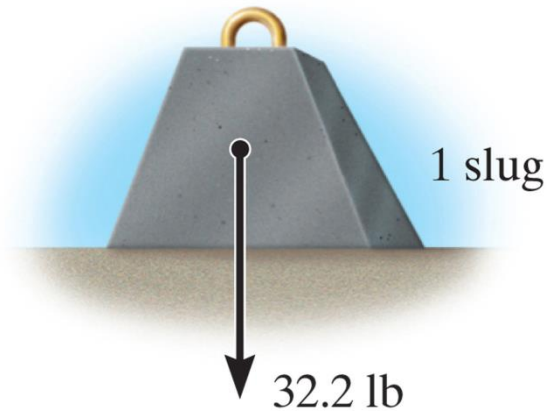
Name	Length	Time	Mass	Force
International System of Units SI	meter m	second s	kilogram kg	newton* $\mathrm{N}\left(\frac{\mathrm{kg}\cdot\mathrm{m}}{\mathrm{s}^2}\right)$
U.S. Customary FPS	foot ft	second s	slug* $\left(\frac{\mathrm{lb}\cdot\mathrm{s}^2}{\mathrm{ft}}\right)$	pound lb

*Derived unit.

pound-mass lbm

Pound-force lbf





$$G = 66.73 \times 10^{-12} \frac{m^3}{kg \cdot s^2}$$

$$g = 9.81 \frac{m}{s^2}$$

$$g = 32.2 \frac{ft}{s^2}$$

General procedure for analysis

1. Read the problem carefully; write it down carefully.
2. MODEL THE PROBLEM: Draw given diagrams neatly and construct additional figures as necessary.
3. Apply principles needed.
4. Solve problem symbolically. Make sure equations are dimensionally homogeneous
5. Substitute numbers. Provide proper units *throughout*. Check significant figures. Box the final answer(s).
6. See if answer is reasonable.

Most effective way to learn engineering mechanics is to *solve problems!*