ES 226 – 02 STATICS

Statics provides an introduction to the analytical methods of engineering design by focusing on the analysis of force systems in equilibrium. Students are required to demonstrate in homework and exams proficiency in working with vector representations of forces, moments, and couples; drawing free body diagrams; analyzing and solving 2-D and 3-D equilibrium problems involving particles, rigid bodies, and structures; analyzing external and internal forces and moments in beam and frame structures; calculating the centroid and moments of inertia of composite cross-sections; and analyzing friction forces.

Prerequisite: MATH162 (Calc II) and PHYS131 (Newtonian Dynamics).

Professor: Anne Raich, Ph.D. 322 ACE raicha@lafayette.edu
330-5590 http://sites.lafayette.edu/raicha

Lecture: MWF 9:00 a.m. – 9:50 a.m., AEC 327
Office Hours: M &W 1:30 p.m. - 3:30 p.m.; T 11:00 a.m .– 12:15 p.m.
Other times, if the door to my office is open, feel free to stop by and ask questions

Textbook: Hibbeler, R.C. Engineering Mechanics: Statics. 11th Ed. Or 12th Ed., Prentice Hall, either Ed. is fine

Exam I: Thursday, March 1st, 2012 (Evening Exam – 7:00 pm to 9:00 pm)
Exam II: Thursday, April 12th, 2012 (Evening Exam – 7:00 pm to 9:00 pm)
Final Exam: T.B.D.
Notes: For all exams you will be able to bring one page of handwritten notes (one-side only). The use of other notes or books during the exam will not be permitted. The final exam is comprehensive.

Grade Distribution: Homework: 15% Exam I: 25% Final Exam: 30%
Video HW Project: 5% Exam II: 25%

Final Grading Scale: A ≥ 92; 92 > A- ≥ 90; 90 > B+ ≥ 87; 87 > B ≥ 82; 82 > B- ≥ 80; 80 > C ≥ 70; 70 > D ≥ 60; F < 60

Expected Workload:
This course requires what is called "*old-fashioned gumption*", as will many other engineering courses you encounter in your studies. There is a lot of homework assigned in the course. The main purpose of the homework is to help you learn the fundamentals of statics, and there is typically a strong correlation between effort on the homework and exam scores. You should expect to spend 8 to 12 hours each week solving homework problems, including reworking problems that you have trouble with (recommended because often these types of problems appear on the exams). Engineers are known for their intellectual curiosity and their willingness to work and these skills allow engineers to rise to positions of leadership.

Learning Objectives:
Specific learning objectives are defined for each class. Learning objectives are tailored to let the student know what skills and knowledge they are expected to learn. Therefore, the learning objectives directly define the skills and knowledge on which the student will be tested in the exams. Full understanding of a learning objective is accomplished through in-class and out-of-class work (i.e. through notes, discussion, demonstrations, reading assignments, and homework).

Attendance and Participation:
Regular and on-time class attendance *is required,* although no grade is assigned for attendance**.** Class participation is expected and provides an opportunity to ask *your* questions, which serve the class at large in learning the course material more thoroughly. You are responsible for all material covered in class, even if absent for authorized activities.

Academic Integrity Statement**:** "Students are expected to be honorable, ethical, and mature in every regard"
No form of scholastic misconduct will be tolerated. Academic dishonesty includes cheating, fabrication, falsification, plagiarism, copying homework from other students or from solution, etc. It is the student's responsibility to comply with the *Lafayette College Student Handbook* (http://www.lafayette.edu/student_life/download_handbook.html) and to be familiar with the *Principles of Intellectual Honesty* (http://www.lafayette.edu/academics/honesty.pdf). Violations will be handled in accordance with the Procedural Standards in Disciplinary Proceedings outlined in the *Student Handbook*.

"I give you two examinations, one in trigonometry and one in honesty. I hope you pass them both, but if you must fail one, let it be trigonometry for there are many good people in this world today who cannot pass an examination in trigonometry, but there are no good people in the world who cannot pass an examination in honesty" - Vanderbilt University past-Chancellor Madison Sarratt

Class	Date		Tentative Topic (Subject to Change)	Required Reading for Class
1	M	1/23	Introduction/ Review of Vector Operations	Review of Chapter 1
2	W	1/25	Review of Vector Operations/Force Resultants	2.1, 2.2, 2.3, 2.4
3	F	1/27	Resolving Force Vectors	2.2, 2.3, 2.4
4	M	1/30	Free Body Diagrams/ Particle Equilibrium	3.1, 3.2, 3.3
5	W	2/1	Particle Equilibrium	3.1, 3.2, 3.3
6	F	2/3	Particle Equilibrium – Design A	3.1, 3.2, 3.3
7	M	2/6	3-D Cartesian Vector Operations	2.5, 2.6
8	W	2/8	Position Vectors, Vector Projections, Dot Product	2.7, 2.8, 2.9
9	F	2/10	3-D Particle Equilibrium	3.4
10	M	2/13	3-D Particle Equilibrium	3.4
11	W	2/15	Moment of a Force – Scalar and Vector Formulations	4.1, 4.2, 4.3
12	F	2/17	Moments of a Forces/Couples – Vector Formulation	4.1, 4.2, 4.3, 4.4
13	M	2/20	Moments about an Axis/Couples	4.5, 4.6
14	W	2/22	Resultants/Equivalent Systems	4.7, 4.8, 4.9
15	F	2/24	Simple Distributed Loading	4.10
16	M	2/27	Connections, Reactions, Free Body Diagrams	5.1, 5.2, 5.3
17	W	2/29	2-D Rigid Body Equilibrium/Free Body Diagrams	5.1, 5.2, 5.3, 5.4
	R	**3/1**	**EXAM I (Evening Exam 7:00 pm – 9:00 pm)**	**Covers Classes 1 - 15**
18	F	3/2	2-D Rigid Body Equilibrium/Two Force Members	5.1, 5.2, 5.3, 5.4
19	M	3/5	Trusses – Method of Joints	6.1, 6.2, 6.3
20	W	3/7	Trusses – Method of Sections	6.3, 6.4
21	F	3/9	Trusses – Zero-Force Members	6.3, 6.4, 6.5
	M,W,F	3/12-3/16	*Spring Break – No Class*	
22	M	3/19	Trusses – Stability, Space, & Design	
23	W	3/21	Trusses – Design B	
24	F	3/23	Pulleys and Frames	6.6
25	M	3/26	Frames	6.6
26	W	3/28	Frames and Machines	6.6
27	F	3/30	Machines	6.6
28	M	4/2	Internal Forces - Beams, Frames, Machines	7.1, 7.2
29	W	4/4	Shear and Moment Diagrams/ Equations	7.2, 7.3
30	F	4/6	Shear and Moment Diagrams/ Equations	7.2, 7.3
31	M	4/9	Shear and Moment Diagrams/Eqns & Graphical	7.2, 7.3
32	W	4/11	Shear and Moment Diagram Graphical	7.2, 7.3
	R	**4/12**	**EXAM II (Evening Exam 7:00 pm – 9:00 pm)**	**Covers Classes thru 30**
33	F	4/13	Shear and Moment Diagrams – Design C	
34	M	4/16	3-D Rigid Body Equilibrium	5.5, 5.6, 5.7
35	W	4/18	3-D Rigid Body Equilibrium	5.5, 5.6, 5.7
36	F	4/20	3-D Rigid Body Equilibrium & Internal Forces	5.6, 5.7, 7.1, 7.2
37	M	4/23	Basic Dry Friction	8.1, 8.2
38	W	4/25	Friction/Wedges	8.3
39	F	4/27	Centroids – Integration & Composite Shapes	9.1, 9.2, 9.3
40	M	4/30	Moments of Inertia – Integration – Mini-Proj. Due	10.1, 10.2, 10.4
41	W	5/2	Moments of Inertia – Composite Areas	10.5
42	F	5/4	Moments of Inertia – Composite Areas – Design D	10.5
FINAL: TBA				

Do you know if you are an active/reflective, a sensing/intuitive, a visual/verbal, and a sequential/global learner? Check out your personal learning style by taking the online quiz at
http://www.engr.ncsu.edu/learningstyles/ilsweb.html.
Read more about your learning styles http://www4.ncsu.edu/unity/lockers/users/f/felder/public/ILSdir/styles.htm

ABET Outcomes:
This course focuses on ABET program outcome (a.), which involves applying math and science principles daily to perform analysis of systems in equilibrium including trusses, frames, and machines. Other outcomes addressed include (j.) and (k.), which involve discussing contemporary structural and mechanical systems, including bridges, buildings, and machines, in order to highlight their impact on the design profession and society, and providing opportunities to gain proficiency in the use of engineering tools and programs through completion of mini-projects.

Students with Disabilities**:** The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation or require assistance with academic concerns/accommodations, please contact the Office of the Dean of Studies (610-330-5080).

Homework Policy:
- Homework is generally assigned after each class and is collected at the beginning of next class meeting, unless otherwise specified. Late homework is accepted **only** by making a **prior** arrangement with the instructor before class (by email), subject to Lafayette College Dean's Excuse Policy outlined in section 7.3.2 of the Faculty Handbook - Class Attendance
- This class emphasizes developing skills in problem solving. All homework should be submitted on engineering paper in a professional manner, which includes neat handwriting and organization. The use of free body diagrams is emphasized along with problem solving techniques. Neatness does count - messy, unorganized problem solutions will result in lower grades. The following should be provided for each problem: A short problem statement about what you are trying to solve for; clear sketches and complete free body diagrams; identification of the analysis steps and calculations made; a check that your answers seem reasonable, and boxes around (or other indication) of your final answer(s).
- Unless otherwise stated, all homework in this class is expected to be individual work. Copying the work of others, including homework, is in violation of the College's Principles of Intellectual Honesty, which can be accessed at http://www.lafayette.edu/academics/honesty.pdf. You may discuss the homework assignments with other students; however all work submitted must be your own. It is your responsibility to properly acknowledge the source of ideas and facts received from others, including from other students, posted solutions, and solution manuals. A student who commits academic dishonesty is subject to a range of penalties, including suspension or expulsion.
- Discussions about re-grading of homework or exams are not conducted in person or by email. To request re-grading, attach a signed statement to your work that details where you feel you lost points and submit it to the professor within one week after the homework or exam has been returned.

Statics Analysis Mini-Project: (Additional details will be provided later in the semester)
- This project involves finding a system that exists in static equilibrium somewhere on campus and describing and discussing the following issues: How the system is constructed; How the system carries loads or is loaded and an estimate of the magnitude of loading; and How you can apply statics concepts and problem solving strategies to determine the reaction forces, pin forces, and internal member forces of the system.
- The system selected for analysis can be a truss, frame, or machine and should be distinct from problems discussed in class. Examples include trusses in and around campus buildings; truss or beam bridges; weight machines; car jacks; press/cutting machines; goal posts; hanging scoreboard or light systems; rigging systems; bike suspensions; cranes; construction equipment; braking systems; folding chairs; etc. If you have questions concerning whether a system is O.K (i.e. can be analyzed using statics), just ask
- You are allowed to work *individually* on this project or on self-selected teams of *two students*. This project must be turned in by 5:00 pm on Monday, April 30th. Projects will be graded for analysis accuracy and clarity of explanation.

Software Used for this Class:
To complete the homework and the analysis project, you are encouraged to use Excel, Matlab, or other programs, which are available on the departments' computers. As engineers you will continually be looking for new tools to apply that make your life easier. How to use Goal Seek in Excel and to use a TI-84ish type calculator to solve matrices will be discussed in-class.

Useful Web-based Tutorial Sites:
There are only a few fundamental concepts in Statics; but many, many, many problems to apply them to. The more problems you think about solving or try solving, the better you will be at recognizing how to solve new problems. Additional examples are provided at these sites:

Statics eCourse: https://ecourses.ou.edu/ **Visual Mechanics**: http://www.drsoftware-home.com/vismech/index.html

MecMovies: http://web.mst.edu/~mecmovie/ **Statics Visualizer (Trusses)**: Free Download – Info provided in class

Learning statics as an engineer is similar to getting a driver's license as a teenager.
It is essential, it allows you to head out on your own, and it helps you get a "date to the big dance" (i.e. job/grad school)

Engineers Have Attitude:

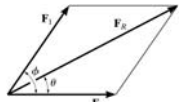
In addition to focusing on picking up basic knowledge and developing technical skills required to solve engineering problems, such as problem solving, critical thinking, teamwork, and communication, there is another goal of all engineering courses. This is to promote an **"engineering attitude"**. The characteristics of having a strong engineering attitude are accepting mistakes, having common sense, patience, ethics, high standards, confidence, persistence, curiosity, flexibility, and understanding that there is not always a single right answer. Students with an engineering attitude possess a well-founded confidence in their ability to solve both routine and novel technical problems.

Those on top of the mountain did not fall there – Anon

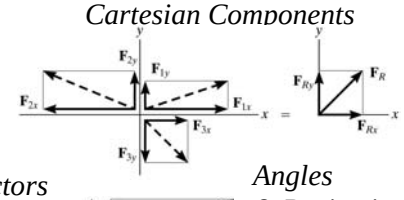
PARTICLE EQUILIBRIUM

↑VECTOR OPERATIONS

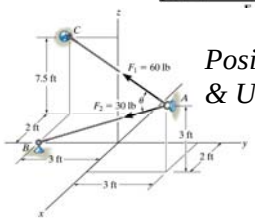
Resultant



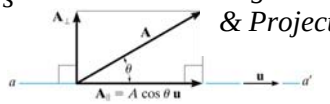
Cartesian Components



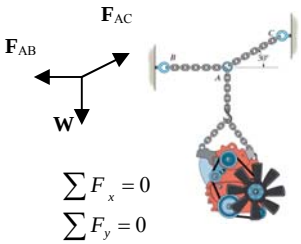
Position & Unit Vectors



Angles & Projections

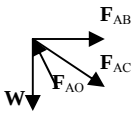


2-D EQULIBRIUM

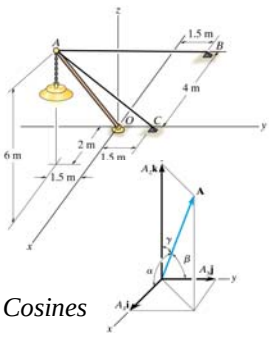


$$\sum F_x = 0$$
$$\sum F_y = 0$$

3-D EQUILIBRIUM



$$\sum F_x = 0$$
$$\sum F_y = 0$$
$$\sum F_z = 0$$

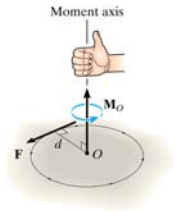


Direction Cosines

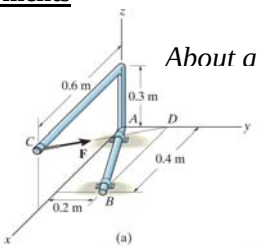
RIGID BODY EQUILIBRIUM

Moments

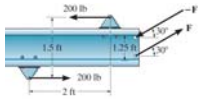
About a Point



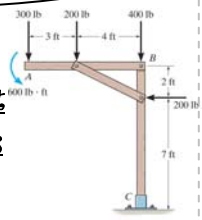
About a Line



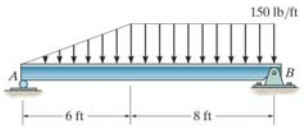
Couple



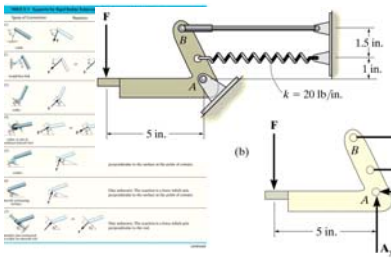
Equivalent Systems



Distributed Loads



2-D RIGID BODY FBDS

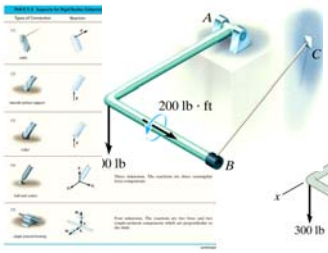


$$\sum F_x = 0$$
$$\sum F_y = 0$$
$$\sum M_{pt} = 0$$

Drawing a FBD

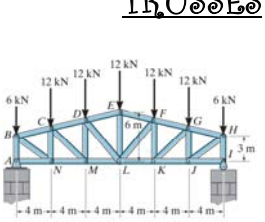
"*Free*" the body from its surroundings and "*Expose*" the forces acting on it "*Show*" all forces/moments (external loads, reactions, internal forces) on the FBD

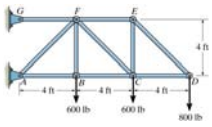
3-D RIGID BODY FBDS



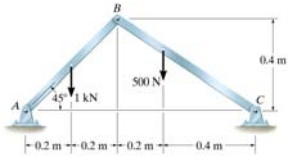
$$\sum F = 0$$
$$\sum M_{pt} = 0$$

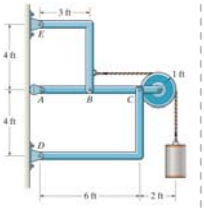
TRUSSES



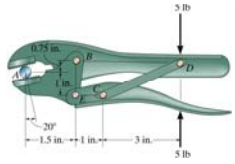


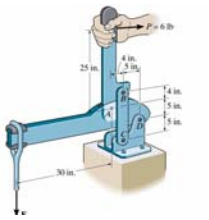
FRAMES



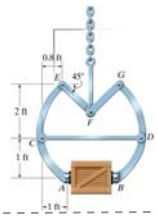


MACHINES



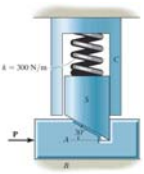


Friction

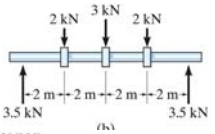


Impending Motion

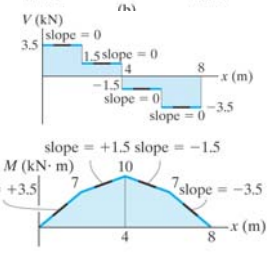
Wedges



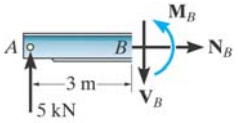
Internal Forces



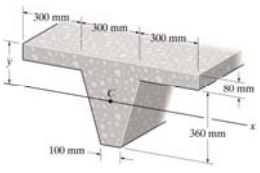
V & M Diagrams

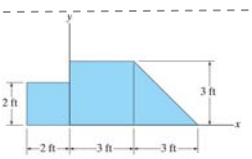


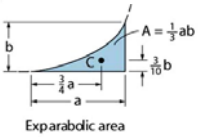
Section Cuts



Centroids

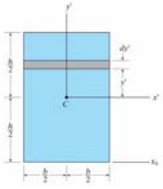


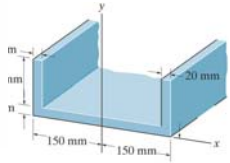




Exparabolic area

MOMENT OF INERTIA





Parallel Axis Theorem

"Nothing is particularly hard if you divide it into small jobs" – Anon