ES 230 – STRENGTH OF MATERIALS (BREMEN)

This course will provide students with the opportunity to learn how to apply the fundamentals of strength of materials as related to concepts of stress, strain, bending, torsion, stability, and deflection of deformable bodies to applications concerning bars, shafts, beams, columns, and pressure vessels. Course material focuses on the fundamentals of applying equilibrium, compatibility of deformations, and force-deformation relationships in solving problems. Students are required to demonstrate proficiency in calculating stresses and strains in bars and beams subjected to axial forces and torsional/ bending moments, and also combinations of these loadings; analyzing external and internal forces and moments; calculating deflections of beams; calculating angles of twist of shafts; determining support reactions for indeterminate bars, shafts, and beams; and design of bars, shafts, and beams.

Prerequisite: Equilibrium forces and moments and analysis of trusses, beams, and frames. ES 226 (Statics).

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Lecture: Mon. 11.15 – 12.30 West Hall 1 & Wed. 8.15 – 9.30 West Hall 3
Office Hours: Mon. 14.00 – 16.00 & Tues. 14.30 – 16.00
Other times, open door policy

Textbook: Hibbeler, R.C., Mechanics of Materials. 6th or 7th Ed. or eBook (any edition after the 5th is fine)

Exam I: Tuesday, March 9, 2010 (Evening Exam – 19.00 to 21.00)
Exam II: Tuesday, April 20, 2010 (Evening Exam – 19.00 to 21.00)
Final Exam: T.B.A.
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:				
	Exam I:	20%	Homework:	20%
	Exam II:	20%	Combined Stress Project:	10%
	Final Exam:	30%		

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, just like Statics, 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 strengths, and there typically is a strong correlation between effort on the homework and exam scores. You should expect to spend 8 to 10 hours each week solving homework problems, including reworking problems that you have trouble with (recommended because often problems like these appear on the exams).

Learning Objectives:
Specific learning objectives are defined for each class. Learning objectives are tailored to let the student know what skills and knowledge the student is expected to learn. Therefore, the learning objectives also 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. 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. You should prepare for class by reading the textbook sections to be covered in-class so that you are ready to discuss basic concepts covered in the reading and example/homework problems from the textbook.

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, multiple submissions, plagiarism, complicity, copying homework, 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*.

Class		Date	Tentative Topic (Subject to Change)	Reading for Class
1	M	2/1	Introduction/Internal Forces by Statics/Normal Stress	1.1, 1.2, 1.3, 1.4
2	W	2/3	Shear Stress/Bolted Connections/Inclined Planes	1.5
3	M	2/8	Allowable Stress/Factor of Safety/Design Examples	1.6, 1.7 (look @ D-1-D-12)
4	W	2/10	Strain/Deformation	2.1, 2.2 (look @ D-13–D-16)
5	M	2/15	Material Properties	3.1,3.2,3.3,3.4,3.6,3.8 (D-17–D-26)
6	W	2/17	Axial I - Member Analysis	4.1, 4.2, 4.3
7	M	2/22	Axial II - Indeterminate Members	4.4, 4.5
8	W	2/24	Axial III – Thermal Stresses and Stress Concentrations	4.6, 4.7 (D-27–D-37)
9	M	3/1	Torsion I - Analysis	5.1, 5.2, 5.3
10	W	3/3	Torsion II - Indeterminate Members	5.4, 5.5, 5.6 (D-38–D-48)
11	M	3/8	Flexure I - V and M Diagrams/M of I	6.1, 6.2, A.1, A.2
	T	3/9	**EXAM I** (Evening Exam 7:00 pm – 9:00 pm)	
12	W	3/10	Flexure II –Flexural Equation/Bending Stresses	6.3, 6.4
13	M	3/15	Flexure III– Bending Stresses/Combined Bending & Axial	6.3, 6.4
	W	3/17	*NO CLASS - BRUSSELS TRIP*	
14	M	3/22	Flexure IV – Composite Beams/Beam Design	6.6, 11.1, 11.2 (D-49–D-60)
15	W	3/24	Shear Stress Equation/Shear Stress Distribution	7.1, 7.2, 7.3
	M	3/29	*SPRING BREAK*	
	W	3/31	*SPRING BREAK*	
	M	4/5	*SPRING BREAK*	
16	W	4/7	Shear Flow/Shear Connectors(Glued/Nailed/Bolted)	7.2, 7.3, 7.4 (D-62–D-67)
17	M	4/12	Pressure Vessels/Combined Loading	8.1, 8.2
18	W	4/14	Combined Loading	8.2 (D-68–D-74)
19	M	4/19	Stress Transformation	9.1, 9.2, 9.3
	T	4/20	**EXAM II** (Evening Exam 7:00 pm – 9:00 pm)	
20	W	4/21	Stress Transformation – Mohr's Circle	9.4, 9.5, 9.6 (D-75–D-80)
21	M	4/26	Strain Transformation	10.1, 10.2
	W	4/28	*NO CLASS – ST. PETE TRIP*	
22	M	5/3	Failure Theories/Strain Gages	10.5, 10.6, 10.7, 9.7
23	W	5/5	Beam Deflection I - Integration	12.1, 12.2, 12.3
24	M	5/10	Beam Deflection II/Indeterminate Beams - Superposition	12.5, 12.6, 12.9 (D-81–D-84)
25	W	5/12	Columns	13.1, 13.2, 13.3 (D-86–D-90)
FINAL: TBA				

ABET Outcomes:
This course focuses on ABET program outcome (a.), which involves applying math and science principles daily to perform analysis of systems by applying concepts of equilibrium, kinematics, and compatibility to axial, torsional, bending, and combined loading problems. 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 the combined stress project.

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) at Lafayette College.

"Problems worthy of attack prove their worth by fighting back" – Paul Erdos

Homework Policy:

- Homework is generally assigned every class meeting and is collected at the beginning of next class meeting, unless otherwise specified. Late homework will be accepted **only** by making a **prior** arrangement with the instructor either during office hours or by email, subject to Lafayette College Dean's Excuse Policy outlined in section 7.3.2 of the Faculty Handbook under the heading Class Attendance
- This class emphasizes developing skills in problem solving. All homework should be submitted on non-spiral-edged paper using one side only in a professional manner, which includes neat handwriting and organization. The following should be provided for each homework problem:
    - Provide a brief written description of the problem being solved and the result requested.
    - Provide well-drawn sketches and all necessary free body diagrams.
    - Clearly identify the analysis steps and calculations made.
    - Provide a summary of your final answers and box them.
    - Check your answers to make sure they seem reasonable.

  Neatness and clarity are important – messy, unorganized problem solutions will not be graded.
- 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. All work submitted, however, must be your own and it is your responsibility to properly acknowledge the source of ideas and facts received from others, including other students. If you work or consult with someone else you will need to identify them by name at the top of your homework as collaborators. 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. If you would like 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.

Combined Stress Project Information:

- The objective of the project is to allow students to take their knowledge gained from working the directed homework problems and apply it to solve a more open-ended engineering problem involving the design of a system that is subjected to combined loading resulting in combined stresses. The project also will involve the creation of an Excel Spreadsheet to simplify the design effort in evaluating the effect of different loading configurations.
- Students will be given a longer time period (3 weeks) to work on the project during the last month of the course. For the project, students can work individually or in teams of two.
- More detailed information concerning the project details concerning analysis, design, and reporting requirements will be presented and discussed in class later in the semester and made available on the course website at that time.

Software Used for this Class:

Students can complete the homework and the project by hand using a calculator, a spreadsheet program like Excel, Matlab, Mathematics, or any other useful programs. As engineers you will continually be looking for new tools to learn and apply that make your life easier. Therefore, you are encouraged to try to use some of the programs.

Useful Web-based Tutorial Sites: Take a look at the following sites to provide additional examples or explanations to the material we cover in class and on the homework. There are only a few fundamental concepts in Strengths; but many, many, many problems to apply them to. The more apps you think about solving or trying to solve the better you will become at recognizing how to solve newly presented problems.

MecMovies: http://web.mst.edu/~mecmovie/statics.htm
Mechanics eCourse: https://ecourses.ou.edu/cgi-bin/ebook.cgi?topic=me
MDSolids: http://www.mdsolids.com/ (30-day free evaluation – then need to purchase the $25 student version)