CE 2205 Mechanics of Materials

Spring 2017
School of Engineering, Vanderbilt University

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Office Hours: MW 4 – 6 pm

Class Hours: Mondays, Wednesdays and Fridays, 11:10 AM – 12 PM

Class Venue: 132 Featheringill Hall

Textbook: Mechanics of Materials (10th Ed.) by R.C. Hibbeler

Prerequisites: CE 2200 (Statics)

Required Course: X **Elective Course:** –

Course Overview: Mechanics of Materials is a subject that deals with the behavior of engineering materials under applied load (e.g., mechanical, thermal) and deformation (e.g., stretching, twisting). Engineering materials are ubiquitous in our modern world, including natural materials (e.g., wood, stone, rubber) and man-made materials (e.g., cast/wrought iron, steel and aluminum alloys, concrete, composites, plastics). The focus of this course is to introduce the theory and methods of calculating stresses and strains in engineering materials and structural members, such as, beams, columns, and shafts. This course aims to explain and describe fundamental questions related to structural strength, safety, and stability, such as,

- How do engineering materials behave under applied mechanical and thermal loads?
- How do engineering materials fail or break under different load configurations?
- How to determine the safe load or strength of a structural member under applied loads?

Course Description (from Course Catalog): Stress and strain; tension, compression, and shear; Hooke's law, Mohr's circle, combined stresses, strain-energy. Beams, columns, shafts, and continuous beams. Deflections, shear and moment diagrams. Prerequisite: CE 2200. FALL, SPRING, SUMMER. [3]

Course Goals: In this course, I have set the following specific goals in terms of knowledge acquisition (content) and skills development.

Content: The goal is to introduce students to the theory and application of the fundamentals of mechanics of materials and prepare them for advanced courses in engineering and design. At the end of the course, you will be able to:

- Define normal and shear stresses and strains in three-dimensions and the stress-strain relations
- Determine material properties from stress-strain curves obtained from laboratory test data
- Analyze axially loaded members (statically determinant and indeterminant) and determine the resulting normal stresses and elongations

- Analyze torsion loaded members with circular cross-sections (statically determinant and indeterminant) and determine the resulting shear stresses and angles of twists
- Determine the bending moment and shear stress distribution in beams and calculate the slope and deflection at any given point
- Apply the concept of stress transformation and determine principal stresses and maximum in-plane shear stresses from a given state of stress
- Apply the concept of strain transformation and determine principal strains and maximum in-plane shear strain from a given state of strain measured using strain rosettes
- Calculate the critical buckling load of columns having various types of support and check for their stability under a given eccentric axial load

Skills: The goal is to enhance to enhance the students' engineering problem-solving, critical thinking and quantitative skills.

- Apply calculus and geometry principles to calculate stress and strains
- Develop algorithms for solving practical engineering problems
- Write project reports and prepare poster presentations using word and powerpoint
- Engaging and supporting critical discussions and thought experiments

Methods of Assessment: There will be four modes of assessment in this course:

1. ***Assigments***: A total of 15 homework and 38 daily tutorial assignments will be assigned on the MasteringEngineering module. Check the "course calendar" on your homepage as soon as you log into MasteringEngineering for the due dates of these assignments. Typically, assignments are due at 11:10 am on the due date. You are also required to submit handwritten paper copies of homework assignments *in class at 11:10 am on the due date* (See Table 1: Course Schedule for more details).

2. ***Exams***: There will be *3 midterms and final exam.* The dates of the exams and topics covered in 1each midterm are given in the course schedule. The final exam is comprehensive in that it covers all topics. A study guide will posted on blackboard and practice problems (no credit) will be assigned on Mastering Engineering at least a week before each exam. Makeup exam will be permitted with proof of medical or personal emergency only.

3. ***Project***: A team projects will be assigned soon after Spring break. Students will be required to assemble into teams consisting of 2-4 students. Each team will *prepare either a project report that they will submit at the end of the course* typically on the last class of the semester. While the project report counts for 10% of the grade, exceptional work can earn bonus points.

4. ***In class-quiz***: There will be occasional in-class quizzes, sometimes within the first few minutes of some of the classes. *Be on time or you will not make it to the quiz.* In class quizzes test the student's grasp on fundamental concepts (i.e., critical thinking rather than their quantitative skills).

Grading (breakdown):

Assignments	30% (10% each for tutorial, online and paper homework assignments)
Midterm Exams	30% (10% for each midterm)
Final Exam	25%
Project	10%
In-class quiz	5%

Policy and Guidelines:

1. ***MasteringEngineering***: While you may buy/rent/borrow a paper copy of the required textbook (either 9th or 10th edition), you should definitely buy the Mastering Engineering access code, preferably before our first class on Monday, January 9. For more details, refer to Get_Started_Flyer_Handout _MasteringEngineering.pdf posted in the Syllabus folder on Blackboard.

2. ***Hand-written homework***: Your homework must be hand-written in a *neat* and *orderly* manner. Include a sketch (free body diagrams, etc.) with each problem when needed. Answers must be *clearly marked* with appropriate *units* indicated. It is strongly recommended that you use 8.5 x 11 plain white sheets or engineering graph paper. You may write on both sides of the paper so long as the text is readable.

3. ***Late assigments***: On MasteringEngineering, late assignments will be awarded reduced credit @ -20% per day late after the due date. However, you will always get a minimum credit of 40% of your score, so make sure to submit the homework online. On the other hand, paper copies of homework assignments submitted with 48 hours of the due date will be given 50% credit and those turned in after 48 hours from due date will be graded, but no credit will be given. In case you have an health issue or personal emergency or ASCE trip, please let the TA or instructor know about this before time, so that they can make an exception on late homework.

4. ***Exams***: All exams are closed book. A two-sided equation sheet is permitted during midterms and final. The equation sheet can contain all relevant materials (e.g. concepts, equations) except worked-out example problems. Only calculators are allowed. Tablets, smart phones or laptops will not be allowed for use as calculators.

Expectations:

What you can expect from the instructor and TAs?

- Respect each of you as individual and unique learners
- Maintain a free and open class environment where you can share your ideas and concerns
- Plan the course well and provide necessary background that is missing in the textbook
- Be on time and prepared for each class
- Solve problems everyday in class and work with you individually, if required
- Provide you guidance on homework assignments out-of-class during office hours
- Provide you assistance in preparing your poster presentations
- Respond to your email queries within 24 hours
- Return graded assignments and exams promptly, and provide feedback
- Maintain a record of grades securely and accurately

What I expect from the students?

- Respect your classmates and the TAs
- Be on time for each class
- Silence or turn off your phone, no emailing or texting during class
- Participate in the discussions in class by answering or asking questions
- Complete assigned textbook readings
- Adhere to Vanderbilt Honor Code in all your work

Honor Code: Honor code is in effect during all exams and homework. Anyone suspected of cheating (i.e., copying off someone else's test/quiz, bringing unauthorized notes to tests, etc.) will be reported to the honor council. For tests students may store equations on calculators, but not solutions to example problems. Access to the previous year's homework and examinations and their solutions (not posted on blackboard) is not allowed. Group discussions in general are permitted, yet all homework must be prepared individually.

Disabilities: Vanderbilt is committed to equal opportunity for students with disabilities. If you have a physical or learning disability, you should contact the Opportunity Development Center to assist you in identifying yourself to your instructors as having a disability, so that appropriate accommodation may be provided.

Relationship of Course to Program Outcomes: Contributes to ABET outcomes a, e and k.

Outcome a: Graduates will demonstrate an ability to apply knowledge of mathematics, science and engineering.

Mathematics, physics and engineering knowledge are the major skills utilized when working with mechanics of materials problems. Students derive governing equations for mechanical and civil engineering systems, and apply engineering knowledge to solve for the loads, stresses and deformation in civil and mechanical engineering problems.

Outcome e: Graduates will demonstrate an ability to identify, formulate and solve engineering problems.

The ability of the students to identify, formulate and solve engineering problems is demonstrated and assessed through homework assignments, in-class discussions and problem solving sessions, and performance during examinations.

Outcome k: Graduates will demonstrate an ability to use the techniques, skills and modern engineering tools necessary for engineering practice.

CE 2205 equips the students with state-of-the-art analytical problem solution techniques that are routinely employed in analysis and design of mechanical and civil engineering structures and materials in engineering practice. CE 2205 graduates are able to address complex practical engineering problems and evaluate them using the analytical techniques and skills acquired during the course.

Emergency Evacuation Plan: In the event of a fire or other emergency, the occupants of this class should take coats and personal belongings and leave the building through the nearest exit. The class should collect in the Stevenson Center Courtyard or the lawn in front of or behind McTyeire Hall according to the evacuation plan. Please review the general evacuation plan and first floor map at
http://engineering.vanderbilt.edu/about/evacuationplans.php.

The assembly point must be at least 50 feet from the building. The assembly point must be at least 50 feet from the building. In the event of an evacuation, students should note who is near them and alert the instructor if anyone is missing on the outside. Do not congregate near response units and activities. VANDERBILT POLICY FORBIDS REENTRY TO A BUILDING IN WHICH AN ALARM HAS OCCURRED WITHOUT AUTHORIZATION BY VANDERBILT SECURITY. If, in consequence of a disability, you anticipate the need for assistance, please discuss that need with the instructor/professor.

Disclaimer: The class schedule, homework assignments and above policies of this course are subject to change by the professor. All students will be notified of any change that might occur during the semester.

Table 1: **Tentative Course Schedule**

Check the MasteringEngineering course calendar for the latest and updated assignment due dates

Class	Date	Topic	Book Chapter	Assignment Due
1	1/9	Introduction	1.1–1.2	
2	1/11	Stress	1.3–1.7	
3	1/13			HW0
4	1/18	Strain	2.1–2.2	
5	1/20	Mechanical properties of materials	3.1–3.7	HW1
6	1/23			
7	1/25			HW2
8	1/27	Axial load	4.1–4.7	
9	1/30			
10	2/1			HW3
11	2/3			
12	2/6			HW4
13	2/8	Buckling	13.1–13.2	
	2/10	Midterm #1	1, 2, 3, 4.1–4.4	
14	2/13	Buckling	13.2–13.3	
15	2/15			HW5
16	2/17	Torsion	5.1–5.5, 5.8	
17	2/20			
18	2/22			HW6
19	2/24			
20	2/27			HW7
21	3/1	Bending	6.1–6.3	
22	3/3			HW8
	3/4 – 3/12	*Spring Break*		
23	3/13	Bending	6.3–6.4	
24	3/15			
	3/17	Midterm #2	4.6–4.7, 13, 5	
25	3/20	Bending	6.5, 6.9	HW9
26	3/22			
27	3/24	Transverse Shear	7.1–7.3	
28	3/27			HW10
29	3/29			
30	3/31	Deflection of Beams and Shafts	12.1–12.2,12.5	
31	4/3			
32	4/5	Pressure Vessels	8.1	HW11
	4/7	Midterm #3	6, 7, 12	
33	4/10	Stress transformation	9.1–9.5	HW12
34	4/12			
35	4/14			
36	4/17			HW13
37	4/19	Strain Transformation	10.1–10.2, 10.6	
38	4/21			
39	4/24	Review and Wrap-up		Project Reports, HW14
	5/2	Final Exam	Comprehensive	