VM513 - Continuum Mechanics, Fall 2018

Lecture Hours: Tuesday & Thursday, 4:00 – 5:40 pm

Course Description: Continuum mechanics is a branch of mechanics that deals with the analysis of the kinematics and the mechanical behavior of materials modeled as **a continuous matter** rather than as discrete particles. Modeling an object as a continuum assumes that the substance of the object completely fills the space it occupies. Modeling objects in this way ignores the fact that matter is made of atoms, and so is not continuous; however, on length scales much greater than that of inter-atomic distances, such models are highly accurate. Continuum mechanics covers fundamental physical laws such as the conservation of mass, the conservation of momentum, and the conservation of energy where differential equations are derived to describe the behavior of a continuous matter in **solid mechanics**, **thermodynamics**, **fluid mechanics**, and **heat transfer**. Continuum mechanics deals with physical properties of **solids** and **fluids** which are independent of any particular coordinate system in which they are observed. These physical properties are then represented by **tensors**, which are mathematical objects that have the required property of being independent of a coordinate system. These tensors can be expressed in coordinate systems for computational convenience.

Learning Objectives:

1. To formulate the equations that describe the motion and mechanical/thermal behaviors of materials.
2. To formulate the conservation principles and constitutive law in the mechanics of continua.
3. To apply these equations to simple problems associated with flow of fluids, heat transfer, and deformation of solid bodies.

Instructor:

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Office hour: Wednesday 5:00-6:00pm
If you communicate with the inbox tool of CANVAS, I will respond within 24 hours. If you communicate via email, I do not guarantee the response.

Textbook:

J. N. Reddy, An introduction to Continuum Mechanics (2nd edition), Cambridge University Press, 2013, ISBN 978-1-107-02543-1

Pre- and Co-requisites:

Solid mechanics, Fluid Mechanics, Heat Transfer, Thermodynamics, Linear algebra

Course Website:

N/A

Grading Policy:

Exam I	25%
Exam II (final exam)	25%
Homework assignments & in-class activities	30%
Term-projects	20%

Note: If a student miss Exam I with an "excused absence," a 15% deduction will be applied to Exam II. Also note that an excused absence is the one that follows the University guidelines and is approved by the instructor.

Attendance Policy:

- It is mandatory for students to attend lecture. If you have to miss lecture, you should inform the instructor ahead of time. Please note that the instructor can assist the student in identifying the material that he (or she) has missed, but a detailed synopsis of the missed lecture will **not** be provided.
- Students must behave professionally during lecture and lab sessions; a use of mobile devices is not allowed.
- Attendance will be checked in a random basis. Maximum 5 points will be given to the final exam as a bonus if a student keeps a good record of attendance with **active participation** to the class.
- According to the new SJTU's education policy, **three times** of absence without prior notification to the instructor results in "**automatic failure** (F)" in the course.

Policy on Homework Assignment

- Every homework assignment should be submitted to the instructor or a TA by the beginning of the class on the due date. A failure of submission of homework on time will get 25% deduction per day.
- Review of the grading: If a student feels that there is a problem on grading, he (or she) could re-submit the homework (or exam) to the TA or instructor for review. However, the review will be conducted by both instructor and TA at a certain extra time.
- Course materials, assignments, and examples will be distributed through the CANVAS system. Important notices will also be circulated through the announcement or inbox tools of CANVAS. ***It is students' responsibility to check the posted information in Canvas and check the course-related emails from their registered email addresses.***

Honor Code Policy:

All assignments (homework and project) should be completed on your own unless specified as group assignments. This means:

- Students are not allowed to sit together and work out the details of the problems with anyone.
- Students are not authorized to discuss the problem set with previous class members, nor anyone else who has significant knowledge of the details of the problems set.
- Nor should you compare your written solutions, whether in scrap paper form or your final work product, with other students (and vice versa).
- You are also not allowed to possess, look at, use, or in any way derive advantage from the existence of solutions prepared in previous years.

Violation of this policy is considered as a violation of the honor code and is grounds for the Instructor(s) to initiate an action that may lead to grade reduction, course withdrawal, University suspension or expulsion. For your information, the UM-STJU JI has a nationally recognized Honor Code of Academic Integrity. This Code sets standards for academic integrity for all students. As a student, you are responsible for upholding these standards. For more information on the Honor Code at UM-SJTU Joint Institute, please visit http://umji.sjtu.edu.cn/academics/academic-integrity/honor-code/. To further exhibit your commitment to academic integrity, after each examination, students must sign their names on the Honor Pledge on the test paper. The Honor Pledge is as follows: "I have neither given nor received unauthorized aid on this examination, nor have I concealed any violations of the Honor Code." Instructors are not required to grade tests in which the signed Honor Pledge does not appear. The Honor Code remains enforced whether or not the student signs the pledge.

Teaching Schedule (tentative):

Week	Lecture	Date	Topics	Chapter	HW
1	1	Tu, 9/11	Introduction of continuum mechanics, definition of a vector	Ch.1	
	2	Th, 9/13	Vector algebra with index notation – scalar and vector products, Reciprocal basis	Ch.2	HW 1
2	3	Tu, 9/18	Summation convention – dummy index, free index,	Ch.2	
	4	Th, 9/20	Transformation law for different bases, theory of matrices	Ch.2	HW 2
3	5	Tu, 9/25	Vector calculus – del operator, divergence and curl of a vector	Ch.2	
	6	Th, 9/27	Vector calculus - Cylindrical and spherical coordinate systems	Ch.2	HW 3
4		Tu, 10/2	National holiday	No lecture	
		Th, 10/4	National holiday	No lecture	
5	7	Tu, 10/9	Tensor – Dyads, Nonion form of a dyad, Transformation of components of a dyad, tensor calculus	Ch. 2	
	8	Th, 10/11	Deformation and configuration, Engineering strain	Ch. 3	HW 4
6	9	Tu, 10/16	General kinematics of a solid continuum	Ch.3	

	10	Th, 10/18	Analysis of deformation –deformation gradient tensor, various type of deformations	Ch.3	HW 5
7	11	Tu, 10/23	Analysis of deformation – Green strain tensor, Analysis of deformation	Ch.3	
	12	Th, 10/25	Analysis of deformation – Principal values and principal planes of strains, Rate of deformation and vorticity tensors	Ch.3	HW 6
8	13	Tu, 10/30	Cauchy stress tensor and Cauchy's formula	Ch.4	
	14	Th, 11/1	Transformations of stress components and principal stresses	Ch.4	HW 7
9	15	Tu, 11/6	Exam (I) – Midterm exam		
	16	Th, 11/8	First- and second- Piola Kirchhoff stress tensors	Ch.4	
10	17	Tu, 11/13	Conservation of mass	Ch.5	
	18	Th, 11/15	Conservation of linear and angular momentum	Ch.5	HW 8
11	19	Tu, 11/20	Thermodynamic principles	Ch.5	
	20	Th, 11/22	Constitutive equations – general principles, Cauchy elastic materials, hyperelastic materials	Ch. 6	HW 9
12	21	Tu, 11/27	Hookean solids – Materials symmetry, orthotropic, isotropic materials	Ch.6	
	22	Th, 11/29	Constitutive equations of fluids	Ch. 6	HW 10
13	23	Tu, 12/4	Constitutive equations of heat transfer	Ch.6	
	24	Th, 12/6	Constitutive equations of coupled problems	Ch.6	HW 11
14	25	Tu, 12/11	Review of continuum mechanics		
	26	Th, 12/13	Exam II (final exam)		