JOHNS HOPKINS
WHITING SCHOOL
of ENGINEERING

Mechanical Engineering 530.605
Mechanics of Solids and Materials I (MSM I)
Fall, 2019 (3 credits)

Instructor
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Office hours: Malone 117, Wednesdays 1 – 2 PM, or by appointment.

Teaching Assistant
Jason Parker (Mechanical Engineering), jparke71@jhu.edu
Office hours: Krieger 170, Thursdays, 1 – 3 PM (Hodson 216, 3 – 5 PM on 10/3, 12/5).

Class Meetings
Monday, Wednesday, 10:30 – 11:45 AM, Malone Hall G33 (unless otherwise indicated below).

Textbooks
Textbook [1] is the primary course textbook and I recommend purchasing a copy for reference. The assigned readings will be from this text and will greatly help you to understand the course content. Textbooks with boundary value problems that we may address towards the end of the course, and much more heavily in MSM II, include [2]–[4]. More rigorous mathematical descriptions of many concepts discussed in this course can be found in [5]–[7]. The textbook [5] is also available in digital form through JHU's library system.

[1] G. A. Holzapfel, *Nonlinear solid mechanics: a continuum approach for engineering science*. Wiley, 2000.

[2] R. J. Atkin and N. Fox, *An introduction to the theory of elasticity*. Courier Corporation, 2013.

[3] M. H. Sadd, *Elasticity: theory, applications, and numerics*. Academic Press, 2009.

[4] Y. Fung, P. Tong, and X. Chen, *Classical and computational solid mechanics*, vol. 2. World Scientific Publishing Company, 2017.

[5] M. E. Gurtin, E. Fried, and L. Anand, *The mechanics and thermodynamics of continua*. Cambridge University Press, 2010.

[6] J. E. Marsden and T. J. R. Hughes, *Mathematical foundations of elasticity*. Courier Corporation, 1994.

[7] C. Truesdell and R. Toupin, "The classical field theories," in *Principles of classical mechanics and field theory/Prinzipien der Klassischen Mechanik und Feldtheorie*, Springer, 1960, pp. 226–858.

Online Resources

Use Blackboard for digital copy of schedule and some reading assignments.

Course Description and Learning Objectives

This course provides an introduction to the mathematical and theoretical foundations of the mechanics of solids and materials. We will begin with the mathematical preliminaries of continuum mechanics: vectors and tensors calculus, then introduce the kinematics of deformation and descriptions of stress in a continuum: Eulerian and Lagrangian descriptions, followed by conservation laws: mass, momentum, and energy balance, and entropy. These concepts will be applied to develop the concepts of constitutive relations: frame invariance, material symmetry, and dissipation. The second half of the class will be devoted to elasticity, both classical and finite elasticity, and solution methods for boundary value problems.

Tentative Course Schedule (Subject to change. T=tentative)

Date	Topic	Remark
8/29	Intro, tensor algebra	
9/4	Tensor algebra and calculus	RH away, JP teaches. HW 1 given 9/6.
9/9	Integral theorems, curvilinear coordinates	
9/11	Coordinate transformations, rotations	
9/17	Kinematics and deformation of continua	HW 1 due, 2 given. Meet at 3:30 PM.
9/18	Deformation gradient, metric changes	
9/23	Deformation decompositions	
9/25	Deformation decompositions, deformation rates	HW 2 due, 3 given
9/30	Deformation rates, linearization	
10/2	Linearization	
10/7	Forces, traction, stress	HW 3 due, 4 given
10/9	Balance laws	
10/15	Review before midterm exam	(T) Meet on Tuesday, 3:30.
10/16	Midterm	
10/21	Balance laws	HW 4 due, 5 given
10/23	Thermodynamics	
10/28	Thermodynamics	
10/30	Objectivity	HW 5 due, 6 given
11/4	Isotropic hyperelasticity: example models, stresses	
11/6	Hyperelasticity: incompressibility, constraints	
11/12	Hyperelastic BVPs: spherical shell, torsion of a cylinder	
11/13	Linear elasticity, linearization of hyperelastic model	HW 6 due, 7 given.
11/18	Principle of minimum potential energy, example	
11/20	Principle min. potential energy with constraints, example	
12/2	Finite strain BVPs: thin and thick-walled cylinder	
12/4	Linear elasticity	HW 7 due.
12/13	**FINAL EXAM**	**Malone G33: 2 – 5 PM**

Grading
Homework (50%), Midterm (25%), Final (25%). Grades will not be curved for individuals. Grading scheme: A+ (97.5-100%), A (92.5-97.49%), A- (89.5-92.49%), B+ (87.5-89.49%), B (82.5-87.49), B- (79.5-82.49%).

Collaboration Policy
You are encouraged to discuss solution strategies to homework problems with other students, but you must find the solutions and write down answers to all questions on your own. Copy solutions on homework and exams is strictly prohibited.

Ethics
The strength of the university depends on academic and personal integrity. In this course, you must be honest and truthful. Ethical violations include cheating on exams, plagiarism, reuse of assignments, improper use of the Internet and electronic devices, unauthorized collaboration, alteration of graded assignments, forgery and falsification, lying, facilitating academic dishonesty, and unfair competition. Report any violations you witness to the instructor.

You can find more information about university misconduct policies on the web at these sites:

- For undergraduates: http://e-catalog.jhu.edu/undergrad-students/student-life-policies/
- For graduate students: http://e-catalog.jhu.edu/grad-students/graduate-specific-policies/

Students with Disabilities
Any student with a disability who may need accommodations in this class must obtain an accommodation letter from Student Disability Services, 385 Garland, (410) 516-4720, studentdisabilityservices@jhu.edu .