Spring 2021

ME 495-H04: Mechanics of Soft Materials

Shawn Chester

Mechanics of Materials

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(Last updated on January 16, 2021)

Class time and location

Friday, 12:30pm - 3:20pm, synchronous online.

Credits and contact hours

This course is 3 credits, with 3 lecture contact hours and no lab component.

Prerequisites

Mech 237 or equivalent.

Required text

L. Anand and S. Govindjee, *Continuum Mechanics of Solids*, 2020, Oxford University Press.

Recommended texts

A.F. Bower, *Applied Mechanics of Solids*, 2009, CRC Press.
G.A. Holzapfel, *Nonlinear Solid Mechanics, A Continuum Approach for Engineering*, 2000, Wiley.
S. Suresh, *Fatigue of Materials*, Second Edition, 1998, Cambridge University Press.
T.L. Anderson, *Fracture Mechanics: Fundamentals and Applications*, Third Edition, 2005, CRC Press.

Grading

Problem Sets: 60%, Project: 35%, Participation: 5%. (There is no final exam, just the project presentation during the allotted final exam time.)

Course description

This course introduces the mechanical behavior of engineering materials and the physical mechanisms that govern their deformation and failure. Major topics: elasticity, viscoelasticity, plasticity, hyperelasticity, fatigue, and fracture. In class experimental demonstrations are conducted to validate the theoretical ideas discussed in the lecture and their application to practical problems.

Purpose and scope

The purpose of this course is to bring advanced topics from the mechanics of materials to the undergraduate curriculum to enhance the standard educational experience for outstanding students. The course is based on content from the Massachusetts Institute of Technology, as well as recent

and ongoing research in Prof. Chester's laboratory. The course presents an overview of multiple contemporary topics related to the deformation and failure behavior of solid materials. This goes above and beyond the standard curriculum which is much more narrowly focused to simple material behavior.

Learning objectives and performance criteria

Students are expected to gain a basic working knowledge of the deformation and failure behavior of solids. This is accomplished through combined lecture and laboratory demonstrations. The specific objectives and performance criteria are:

1. Linear elasticity. Evaluated on problem sets and the project: 80% of the students will earn a grade of 70% or better.
2. Linear viscoelasticity. Evaluated on problem sets and the project: 80% of the students will earn a grade of 70% or better.
3. Small strain plasticity. Evaluated on problems sets and the project: 80% of the students will earn a grade of 70% or better.
4. Fracture. Evaluated on problems sets and the project: 80% of the students will earn a grade of 70% or better.
5. Fatigue. Evaluated on problem sets and the project: 80% of the students will earn a grade of 70% or better.
6. Hyperelasticity. Evaluated on problem sets and the project: 80% of the students will earn a grade of 70% or better.

Academic integrity

The NJIT honor code will be upheld and any violations will be brought to the attention of the dean of students.

Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found here.

Please note that it is the professional obligation and responsibility of faculty to report any academic misconduct to the Dean of Students Office. Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university. If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu.

Communication

This course will make use of Canvas for dissemination of various materials. Also, you will be regularly contacted via email at your NJIT email address.

Project

An *individual or group* project focusing on a topic of the students choice will be presented during the final exam period. Details will be determined by the students enrolled later in the semester.

Problem sets

Problem sets are regularly assigned, and collected via Canvas. The solutions will be posted online and no assignments will be collected after solutions are posted. The due dates are subject to change as the semester progresses.

Tentative schedule

Lecture	Day	Topic
1	1/22	Introduction. Axial loads, torsion, beam bending, column buckling (buckling demo).
2	1/29	Mathematics. Strain in 3D.
3	2/5	Stress in 3D. Equilibrium.
4	2/12	Linear elasticity.
5	2/19	Linear elasticity (stress concentration demo). Limits to linear elastic behavior, yield.
6	2/26	Linear elastic fracture mechanics.
7	3/5	Linear elastic fracture mechanics (fracture demo).
8	3/12	Small strain elastic-plastic behavior metals (plasticity demo).
-	3/19	*Spring break*
9	3/26	High temperature creep behavior of metals (creep demo).
-	4/2	*Good Friday*
10	4/9	Small strain viscoelasticity of polymers.
11	4/16	High cycle fatigue.
12	4/23	Low cycle fatigue.
13	4/30	Hyperelasticity.
14	5/4	Hyperelasticity (rubber demo).