Last updated: **August 25, 2025**

Advanced Soft Tissue Mechanics – Fall 2025

Course Information

Course Number	BMEN 6399
Course Title	Advanced Soft Tissue Mechanics
Course Credits	3 Credit Hours
Term	Fall 2025
Location	This course will be taught in-person in the TI-BMES building (**EA3.408**) at UTSW and will be virtually linked to a distance-learning-enabled classroom at UT Dallas (**BSB 11.102E**). Students are welcome to attend in-person at either location.
Days & Times	Monday/Wednesday 11:30am – 12:45pm

Contact Information

Instructor

Professor	Jacopo Ferruzzi, PhD
Office Phone	+1 (972) 883-4628
Email Address	jacopo.ferruzzi@utdallas.edu
Office Location	EA 3.200D
Online Office Hours	Mondays 5:00pm – 6:00pm via MS Teams
Other Information	Additional office hours by appointment (setup via UTD email)

Course Prerequisites

Prerequisites:	MATH 2415 or MATH 2419, BMEN 3399 or graduate standing

A working knowledge of linear algebra and multivariable calculus is a requirement for this class.

Course Description

This course covers advanced topics in the biomechanics of soft tissues and biomaterial scaffolds. Concepts in nonlinear continuum mechanics will be presented and expanded to solve a variety of bioengineering problems. In each case, the basic anatomy and physiology of specific tissue types will be used to motivate the use of appropriate constitutive models. Relevant boundary value problems will be solved using analytical and numerical techniques. Special emphasis will be placed on the analysis and interpretation of data from complex biomechanical testing to show how experimental, theoretical, and computational methods can be integrated to gain a deeper understanding of the underlying mechanobiological processes of soft tissue remodeling.

Learning Objectives/Outcomes

1. Develop a working knowledge of nonlinear continuum biomechanics. (ABET 1)
2. Use constitutive modeling to describe the pseudo-elastic behavior of soft tissues. (ABET 1)
3. Solve boundary-value problems of pathophysiological relevance. (ABET 1)
4. Learn approaches and tools to conduct and interpret biomechanical experiments. (ABET 6)
5. Present and discuss modern soft tissue mechanics topics from the literature. (ABET 3)

Textbooks and Materials

Key References (Textbooks are on reserve at the UTD Bookstore and can be ordered online):

- Fung, Y. C. 1993. *Biomechanics: Mechanical Properties of Living Tissues*. Springer.
- Holzapfel, G. A. 2000. *Nonlinear Solid Mechanics: A Continuum Approach for Engineering*. Wiley.
- Humphrey, J. D. 2002. *Cardiovascular Solid Mechanics: Cells, Tissues, and Organs*. Springer.
- Humphrey, J. D. and O'Rourke, S.L. 2015. *An Introduction to Biomechanics: Solids and Fluids, Analysis and Design*. Springer.
- Taber, L. A. 2020. *Continuum Modeling in Mechanobiology*. Springer.

Grading Policy

The final grade will be determined as follows:

- Homework (20%)
- Reading Assignments (10%)
- Exam (30%)
- Paper (20%)
- Laboratory-based Modeling Project (20%)

From the percentage points, letter grades will be assigned according to the following table.

Letter Grade	*% Points*	*Letter Grade*	*% Points*	*Letter Grade*	*% Points*	*Letter Grade*	*% Points*
A+	97-100	**B+**	87-89.99	**C+**	77-79.99	**D+**	67-70
A	93-96.99	**B**	83-86.99	**C**	73-76.99	**D**	63-66.99
A-	90-92.99	**B-**	80-82.99	**C-**	70-72.99	**D-**	60-62.99
						F	< 60

Specifically, A reflects excellent performance, B good, C fair, and D poor.

Homework: Homework will be assigned roughly every other week. On the due date, a PDF copy of the worked-out solution should be emailed to the instructor by end of day (i.e., 11:59pm CST).

Reading Assignments: Journal articles will be assigned roughly every other week. For each reading assignment, students will submit a one-page summary using the template provided by the instructor.

Paper: Each student will perform a literature search on a soft tissue mechanics problem of their interest and prepare a report on that topic, upon receiving the instructor's approval. The goal is to review at least 5-10 journal articles and summarize that state of the art in that specific research area. The report should be a maximum of 10 pages (typed with 12pt typeface, double-spaced, 1 inch margin), excluding references and figures.

Exam: There will be one exam, covering the biological and theoretical bases of the material presented during the semester. All exams will be closed-book, but you will be allowed to bring 1 double-sided pages (2 pages in total) of handwritten or typed notes.

Laboratory-Based Modeling Project: Each student will complete a term project with the goal of gaining in-depth understanding of the experimental characterization of soft biological tissues. Each student will write a computer code for data analysis (using Matlab, Python, or similar language) and investigate the interplay between experimental data and theory.

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Academic Calendar

Note: *Some dates may be subject to change at the discretion of the Professor; changes will be announced in class, via email, and on eLearning.*

WEEK/ DATES	TOPIC/LECTURE	READING	ASSESSMENT / ACTIVITY	DUE DATE
1 08/25-08/29	Biological motivation, Vascular structure	Humphrey, O'Rourke Chapter 1		
2 09/01-09/05	Labor Day, Linear elasticity review		Paper 1	09/11
3 09/08-09/12	Tensors and their properties, dyadic product, Kronecker delta	Holzapfel, Chapter 1	HW 1	09/18
4 09/15-09/19	Vascular function, Introduction to kinematics	Humphrey, Chapter 7 (7.1-7.2)	Paper 2	09/25
5 09/22-09/26	Deformation gradient tensor, Measures of strain	Taber, Chapter 3 (3.1-3.2)	HW 2	10/02
6 09/29-10/03	The concept of stretch, Problems and examples	Taber, Chapter 3 (3.3)	Paper 3	10/09
7 10/06-10/10	Vascular mechanics: kinematics, The opening angle	Humphrey, Chapter 7 (7.3-7.4)	HW 3	10/16
8 10/13-10/17	Tractions and stress, Cauchy Theorem	Taber, Chapter 3 (3.4)	Paper 4	10/23
9 10/20-10/24	Alternative measures of stress, Problems and examples	Taber, Chapter 3 (3.5)	Report approval	11/05
10 10/27-10/31	Review and exam, Vascular mechanics: stress	Humphrey, Chapter 7 (7.3-7.4)	**Exam**	**10/28**
11 11/03-11/07	Constitutive formulation: Theoretical framework	Fung, Chapter 2 (2.1-2.3)	HW 4	11/13
12 11/10-11/14	Constitutive formulation: Linear models	Fung, Chapter 2 (2.8)	Paper 5	11/20
13 11/17-11/21	Constitutive formulation: Nonlinear models (isotropic)	Taber, Chapter 3 (3.6)	HW 5	12/04
14 11/24-11/28	Fall Break			
15 12/01-12/05	Constitutive formulation: Nonlinear models (anisotropic)	Humphrey, Chapter 7 (7.5-7.6)	**Report**	**12/08**
16 12/08-12/12	Vascular mechanics: constitutive modeling and data analysis		**Project**	**12/12**

Grading Errors
If you think we have made an error in grading, please email the original assignment to the instructor and TA within one week of receiving the grade with a note that outlines what you perceive to be the error, problem or discrepancy. Grades will be posted on eLearning. All questions regarding grades should be handled in office hours or via UTD email.

Course & Instructor Policies
Life policy
Life happens and personal situations can introduce complication. Please talk to the instructor if you need assistance regarding class. The instructor wants you to succeed and early communication is key. Allowances for exceptional documented circumstances will be accepted with prior consent of the instructor. In such circumstances, late work will be dealt with on a case-by-case basis. Contact the instructor and TA by email as soon as practical if these circumstances may apply to you. The email reply documenting acceptance of reason and documentation for late work will set a new deadline

Make-up exams
Missed exams without advanced notice or documented reason will receive a zero. Missed exams **with prior notification** of absence for documented reasons (e.g., illness with doctor's note) can be replaced by a make-up exam. The email reply documenting acceptance of reason for missing or rescheduling an exam will set the time and nature of make-up exam.

Late Work
Unless otherwise specified in class or on eLearning, all assignments are due 11:59 pm on the indicated night. **Assignments turned in after the due date and time will be assessed a penalty of 25% per 24 hours.** Email the assignment to the instructor directly if you experience or expect an error submitting an assignment on eLearning. **Late work will not be accepted without the prior consent of the instructor, with allowances for exceptional documented circumstances. In such circumstances, late work will be dealt with on a case by case basis. Contact the instructor and TA by email as soon as practical if these circumstances may apply to you.** The email reply documenting acceptance of reason and documentation for late work will set a new deadline.

Cheating
Please do not cheat. Do not copy assignments, do not post assignments or make answers public, do not plagiarize, do not use the internet or outside sources when you are not allowed to. You may work on homework assignments with your peers, but please make note of those you did the assignment with. If the instructor suspects academic dishonesty, they will follow UTD procedures with the Office of Community Standards and Conduct (OCSC) from which point forward the instructor will no longer be involved in the investigation or results. The instructor will not notify a student of a report to OCSC, nor will they discuss pending investigations with the student. Do not cheat.

Class Participation
This course involves extensive problem solving. Successful mastery of the material requires focused effort and practice throughout the semester. Contact the instructor if you need additional help or some aspect of the course is not working well for you.

Classroom Citizenship
Please be respectful of your peers at all times. Please keep discussion board comments constructive and on-topic.

Privacy
UTD takes your privacy very seriously. The instructor is unable to email grades or discuss grades by email. Grades will be posted on eLearning and all questions regarding grades should be handled in office hours.

Artificial Intelligence (AI) Policy
The use of AI tools such as ChatGPT is allowed in this course under very specific circumstances. For homework, Pearson's Mastering Engineering provides an AI help tool for selected problems. You are free to use that tool and other AI tools to help you set up the problems. For the final project, you must clearly indicate any use of AI tools and provide appropriate citations or references for any AI-generated content or results produced. This should include full documentation of exactly how the tool was used. *AI should not replace your individual effort or original work but rather, should be used as supplemental resources to support your own analysis, critical thinking, and problem-solving*. For quizzes and exams, use of any external resource (AI, Google, other students, etc.) is strictly prohibited. Any misuse or violation of the policy, including unauthorized or excessive use of AI, will be considered a breach of academic integrity and subject to disciplinary actions as per the institution's policies and procedures on academic misconduct.
(Adapted from the University of Nebraska's A.I. Policies)

Acceptable uses:

- Using AI to help brainstorm ideas and organize thoughts.
- Using AI image generators to create visuals.
- Using AI to help with grammar and spelling checks.
- Using AI to explain confusing concepts in simple language.
- Using AI to translate text from one language to another.

Unacceptable uses:

- Using AI to generate content for assignments.
- Using AI to plagiarize content from other sources.
- Using AI to answer exam or quiz questions.
- Using AI to automate the completion of assignments.

Class Materials
The instructor may provide class materials that will be made available to all students registered for this class as they are intended to supplement the classroom experience. These materials may be downloaded during the course, however, these materials are for registered students' use only. Classroom materials may not be reproduced or shared with those not in class, or uploaded to other online environments except to implement an approved Office of Student AccessAbility accommodation. Failure to comply with these University requirements is a violation of the Student Code of Conduct.

Class Attendance
The University's attendance policy requirement is that individual faculty set their course attendance requirements. Regular and punctual class attendance is expected regardless of modality. Students who fail to attend class regularly are inviting scholastic difficulty. In some courses, instructors may have special attendance requirements; these should be made known to students during the first week of classes. These attendance requirements will not be used as part of grading (see Class Participation below for grading information).

Class Participation
Regular class participation is expected. Students who fail to participate in class regularly are inviting scholastic difficulty. *This course involves extensive problem solving. Successful mastery*

of the material requires focused effort and practice throughout the semester. Contact the instructor if you need additional help or some aspect of the course is not working well for you.

A portion of the grade for this course is directly tied to your participation in this class. It also includes engaging in group or other activities during class that solicit your feedback on homework assignments, readings, or materials covered in the lectures (and/or labs). Class participation is documented by faculty. Successful participation is defined as consistently adhering to University requirements, as presented in this syllabus. Failure to comply with these University requirements is a violation of the Student Code of Conduct.

Class Recordings

The instructor may record meetings of this course. These recordings will be made available to all students registered for this class if the intent is to supplement the classroom experience. If the instructor or a UTD school/department/office plans any other uses for the recordings, consent of the students identifiable in the recordings is required prior to such use unless an exception is allowed by law. Students are expected to follow appropriate University policies and maintain the security of passwords used to access recorded lectures. Unless the Office of Student AccessAbility has approved the student to record the instruction, students are expressly prohibited from recording any part of this course. Recordings may not be published, reproduced, or shared with those not in the class, or uploaded to other online environments except to implement an approved Office of Student AccessAbility accommodation. Failure to comply with these University requirements is a violation of the Student Code of Conduct.

Resources

Student Success Center: Provides Peer Tutoring for students in BMEN 2320.

Academic Support Resources: The information contained in the following link lists the University's academic support resources for all students.

Student Resources: A variety of resources are available to help students to obtain counseling, health care, and academic support.

Student Services & Support: UTD services to support students in and out of the classroom.

Resources for Study and Campus Life: Additional list of resources at UTD.

Technical Requirements

In addition to a confident level of computer and Internet literacy, certain minimum technical requirements must be met to enable a successful learning experience. Please review the important technical requirements on the Getting Started with eLearning webpage.

Course Access and Navigation

This course can be accessed using your UT Dallas NetID account on the eLearning website. Please see the course access and navigation section of the Getting Started with eLearning webpage for more information. To become familiar with the eLearning tool, please see the Student eLearning Tutorials webpage. UT Dallas provides eLearning technical support 24 hours a day, 7 days a week. The eLearning Support Center includes a toll-free telephone number for immediate assistance (1-866-588-3192), email request service, and an online chat service.

Communication

All official student email correspondence will be sent only to a student's UT Dallas email address and UT Dallas will only consider email requests originating from an official UT Dallas student

email account. At some points in the term, my inbox gets quite full, but I do want to hear from you. If you email me, please wait 1 business day for all email responses. If you do not receive an email within that time period, please send a follow-up email or reach out in-person. I will appreciate the gentle reminder.

This course utilizes online tools for interaction and communication. Some external communication tools such as regular email and a web conferencing tool may also be used during the semester. For more details, please visit the Student eLearning Tutorials webpage for video demonstrations on eLearning tools. Student emails and discussion board messages will be answered within 3 working days under normal circumstances.

UTD takes your privacy very seriously. The instructor is unable to email grades or discuss grades by email. Grades will be posted on eLearning and all questions regarding grades should be handled in office hours.

Server Unavailability or Other Technical Difficulties
The University is committed to providing a reliable learning management system to all users. However, in the event of any unexpected server outage or any unusual technical difficulty which prevents students from completing a time sensitive assessment activity, the instructor will provide an appropriate accommodation based on the situation. Students should immediately report any problems to the instructor and also contact the online eLearning Help Desk. The instructor and the eLearning Help Desk will work with the student to resolve any issues at the earliest possible time.

Accommodations for Students with Disabilities
It is the policy and practice of UT Dallas to make reasonable accommodations for students with properly documented disabilities. If you are a student with a disability and believe you will need academic accommodations for this class, you are encouraged to register with the Office of Student AccessAbility (OSA). Some aspects of the course, the assignments, the in-class activities, and the way the course is typically taught may be accommodated to facilitate your participation and progress. OSA will assist you in determining academic accommodations that are appropriate for your situation. Any information you provide is private and confidential and will be treated as such. To avoid any delay, please contact OSA as soon as possible. Please note that accommodations are not retroactive and disability accommodations cannot be provided until an OSA Letter of Accommodation has been given to the instructor. Students who have questions about receiving accommodations, or those who have, or think they may have, a disability (mobility, sensory, health, psychological, learning, etc.) are invited to contact OSA for a confidential discussion. OSA is located in the Administration Building, AD 2.224 They can be reached by phone at 972-883-2098, or by email at studentaccess@utdallas.edu.

Academic Support Resources
The information contained in the following link lists the University's academic support resources for all students.

Please see http://go.utdallas.edu/academic-support-resources.

UT Dallas Syllabus Policies and Procedures
The information contained in the following link constitutes the University's policies and procedures segment of the course syllabus. Please review the catalog sections regarding the credit/no credit or pass/fail grading option and withdrawal from class.

Please go to http://go.utdallas.edu/syllabus-policies for these policies.

Comet Creed

This creed was voted on by the UT Dallas student body in 2014. It is a standard that Comets choose to live by and encourage others to do the same:

"As a Comet, I pledge honesty, integrity, and service in all that I do."

The descriptions and timelines contained in this syllabus are subject to change at the discretion of the Professor.