

BMED/ME 4758/6743 – Biosolid Mechanics
Fall 2026 – Syllabus
T/Th 2:00-3:15 (Boggs, Room B5)

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Office hours: T/Th 3:15-4:15 (Location TBD)

TA's: TBD

Welcome: Welcome to Biosolid Mechanics! This course is very near and dear to our hearts, and we hope to be able to introduce you to the amazing world of the mechanical behavior of tissues. You will find they are complex, fascinating and wonderful.

Catalog Description:

The mechanics of living tissue, e.g., arteries, skin, heart muscle, ligament, tendon, cartilage, and bone. Constitutive equations and some simple mechanical models. Mechanics of cells. Applications.

Purpose: The overall objective of this course is to provide students with the mathematical preliminaries and theoretical framework to analyze the mechanics of biological materials. Much of the course will consider modeling biological tissues as non-linear, elastic, homogeneous, anisotropic, incompressible materials. Additional consideration will be given to viscoelasticity, heterogeneities, and linearized elasticity and quasi-linear viscoelasticity.

Objectives: At the end of the course students should be able to:

1. Perform basic tensor algebra operations and employ index notation to manipulate expressions containing scalar, vector and second-order tensors.
2. Understand the concepts and various definitions of stress and strain and identify the 3D state of stress and strain under different loading scenarios, including uniaxial and biaxial extension and compression, simple and pure shear, and inflation and extension of a residually stressed tube.
3. Delineate the general mechanical characteristics of different biological materials and identify an appropriate theoretical framework to perform stress analysis on these materials.
4. Apply the basic postulates of classical physics (conservation of mass, linear and angular momentum, and energy and the entropy inequality) to determine the 3D distribution of stress and strain in biological tissues under various loading scenarios with a given constitutive equation.
5. Apply the basic postulates of classical physics to formulate constitutive equations and determine material parameters for biological tissues modeled as non-linear, elastic, heterogeneous, anisotropic, incompressible materials.

Textbooks: *Cardiovascular Solid Mechanics*, JD Humphrey, Springer, 2004.
Biomechanics. Mechanical Properties of Living Tissues, 2nd Edition, YC Fung, Springer, 1993.
An Introduction to Continuum Mechanics, J.N. Reddy, Cambridge University Press, 2007.
Nonlinear Solid Mechanics: A Continuum Approach for Engineering, G.A. Holzapfel, Wiley, 2000.

The above books are suggested (**not required!**) references. The class will most closely follow the book by Humphrey. Additionally, detailed class notes will be available to download from Canvas.

Prerequisites: BMED 3400 (Introduction to Biomechanics) or COE 3001 (Mechanics of Deformable Bodies), or equivalent.

Honor Code: Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards and students are expected to abide by the GT Honor Code (www.honor.gatech.edu) at all times. The objective of the honor code is “to prevent any students from gaining an unfair advantage over other students through academic misconduct”. Please adhere to this code and take it seriously; both instructors certainly do and have a zero-tolerance policy for code violations.

Examples of honor code violations include:

- Communicating with other students during a quiz, test or exam.
- Claiming other students’ work as your own.
- Using notes of any kind during closed-book, in-class examinations
- Making untrue claims/statements (of any sort) to the instructors regarding use of electronic resources (your personal laptop crashing, etc.)

For any questions involving these or any other Academic Honor Code issues, please consult your instructor or visit www.honor.gatech.edu.

Accommodations for Students with Disabilities:

If you are a student with learning needs that require special accommodation, contact the Office of Disability Services at (404) 894-2563 or <http://disabilityservices.gatech.edu>, as soon as possible, to make an appointment to discuss your special needs and to obtain an accommodations letter. We fully support and recognize the need to make accommodations that improve teaching and learning for all students. Please also e-mail us as soon as possible to set up a time to discuss your learning needs.

Lectures: This class will be run using a “flipped” format. What does that mean in practice?

- We have recorded a series of lectures that present the underlying concepts; these lectures are available on Canvas in the “Media Gallery” and you can refer to them any time during the term. Please, please look at the lectures online **before** the relevant classes.
- We will use the class slot for a few different purposes:
 - Some days, we will have a problem-solving studio where students will work in small groups to solve the homework problems. This will be in-person.
 - Other days, we will have an in-person lecture. In this lecture we will work problems on the board, and will answer questions that students may have.
- There are a few exceptions to the above general outline
 - We will use several lecture slots for the two term tests.
 - Towards the end of term, graduate students will give lectures on a topic. This is an opportunity for all students to become subject matter experts and demonstrate your awesome knowledge of Biosolid mechanics. The lectures will be graded (more details below).

Keys to Success:

There are several keys to success in this class.

- First and foremost, be excited to learn and be passionate about understanding the underlying concepts of tissue mechanics.
- Seek understanding, rather than just getting the correct answer.
- Conduct course activities in a timely manner; watch lectures (well) before the due date and take notes during the lecture, engage in the class examples and PSS activities
- Participate with your group work, and in discussion during the class meetings and group check-ins.
- Review materials and problem sets (well) prior to quizzes, term tests, and exams. Go over the solutions carefully and understand the concepts behind the solutions, not just the steps and math to solve the problem.
- Ask questions! It is critical that you dialogue with your PSS group and the instructor and TA.

Grading:

This is a mixed graduate/undergraduate class. Students will work together but some aspects of the evaluation will differ between graduate and undergraduate students. Also, we have designed the class so that there are multiple “small stakes” assessments, as follows:

Term Tests (see below)	30% total (15% each x 2 tests)
Quizzes (see below)	20% total (5% each x 3 quizzes + 3 x 2% pop quizzes)
Student Project	25% total (see details below)
Final Exam	25% (comprehensive)

Student Project:

A student group project is an important part of this course, designed to achieve an important goal: to teach students the fundamental ‘language’ used in tissue mechanics, so that students can study high-level papers in the field of biomechanics. This course project is a culmination and demonstration that you have gained these skills throughout the semester.

Students will form groups consisting of either all graduate students or all undergraduates. The standard format for group projects will involve critical reading and review of one current, relevant research paper per group (list of papers to be provided in due course, with option for groups to choose their own paper with prior approval). However, it is also possible for groups to instead choose a specific topic, such as those listed below:

- Linear / quasi-linear visco-elasticity
- Finite viscoelasticity
- Poroelasticity
- Linear elasticity (e.g., in bone mechanics)
- Modeling muscle contractility
- Cell mechanics
- Tissue growth & remodeling
- Finite element analysis with a tissue mechanics application
- Other topics of your choice

Grade evaluation for this project will differ between undergraduate and graduate student, as described in detail below.

For graduate student teams: Graduate student groups will deliver a 20-minute lecture (half period) on the chosen topic. Students must consult with one of the instructors at least 1 week in advance of the lecture and provide an outline of the material that will be covered in the lecture.

The Course Instructors will ultimately assign the final project grade for graduate students in each team. However, peer-review feedback will be used to help the Course Instructors to assign grades. Students in the course will be asked to complete surveys to answer questions, such as:

- Rate the clarity of the lecture material and your ability to understand and follow the lectures.
 - Adequate visual aids, appropriate lecture time, well organized, clear statements and concepts, and appropriate definitions of terms, symbols, etc.
 - Was there breadth of material covered appropriate? Was the content correct? Did the team tie this material into the framework of the rest of the course? Did the team provide adequate linkages between mechanics and biology/physiology?
- Rate the level of engagement, stimulation of interest, and class interaction
 - Did the lecture stimulate your interest in the topic? Were the presenters engaging and excited about the material?
 - What was the greatest strength of the lecture material? What was the greatest weakness of the lecture material?

We will also ask each student, individually, to provide critical peer reviews of the other group presentations, including strengths and weaknesses of each presentation that align with the overall scoring of the presentation. Your peer reviews will be graded for completeness and thoughtfulness of your comments and scores. Giving all other groups a 100% and saying 'it was a great presentation' is not very thoughtful. If it was really a 'perfect' presentation, then list the strengths that justify your score. Similarly, giving a group a score of 50%, with few critiques to justify your score, is also not a thoughtful review.

For undergraduate students: Undergraduate student groups will prepare a concise set of lecture notes (similar to class notes) and prepare an exam question and solution key based on the paper/topic selected by the group. Grading of this question will be done by the instructor(s) and will be based on: how well the exam question links to concepts covered in the relevant lecture as well as more broadly throughout Biosolid Mechanics; technical correctness; creation of a problem that is at a suitable level of difficulty (non-trivial, but also solvable by an average 4000-level student in a reasonable amount of time under exam conditions); and the clarity of the writing/exposition.

Homework: Over the course of the term, a number of problem sheets will be assigned. They will not be graded. Instead we will work through them in problem-solving sessions. Note that term test and final exam problems will be similar to those in problem sheets, and students cannot realistically expect to pass the course without completing the problem sets. Problem sheet solutions will be posted on Canvas.

Quizzes: There will be 3 quizzes: 2 short in-class quizzes (see class schedule) plus one "quiz" that you turn in. For the in-class quizzes: **Unlike the term tests and the final exam, no formula sheet will be provided for the quizzes.** Each quiz will be 15 minutes in duration and will be based on material taken directly from the preceding problem sets. Students who have completed and understood the relevant problem sets can expect to score extremely well on the quizzes. No make-up quizzes will be offered. The turned in quiz will be explained as the term progresses. The overall Quizzes grade will be the arithmetic average of grades from the three quizzes.

Term Tests: See the class schedule for the date of the term tests, which will each be 80 minutes in duration.

Final Exam: The final exam date and time are not flexible. No request to take the final exam at an alternative time or date will be allowed for any reason. **You must attend your assigned final time for taking the exam.**

Absence policy: *Planned absences:* Except for approved Institute activities, permission to miss a scheduled quiz/test/exam will only be given in extremely unusual circumstances. We require that all planned absences be supported by documentation in advance of the planned absence. Therefore, planned absence from a quiz, term test, presentation and/or exam without prior discussion with the instructors and their approval will automatically result in a mark of zero for that quiz/term test/presentation/exam, with no exceptions.

Unplanned absences: If a student is unavoidably absent from one or more quizzes, terms test, presentation or the final exam, he/she must notify the professor as soon as practically possible. The reason for the absence must be communicated and documentary evidence provided, e.g. a doctor's note in case of illness. Failure to provide suitable documentary evidence and/or timely notification will automatically result in a mark of zero for that quiz/term test/presentation/exam, with no exceptions.

Formula Sheet: We will provide formula sheets for the final exam and the term tests. Other materials are not allowed.

BMED/ME 4758/6743: Biosolid Mechanics Fall 2026 – Course Schedule

DATE	DAY	LECTURER	CLASS-TIME ACTIVITIES	HOMEWORK
25-Aug	Tues	Gleason	Syllabus, Course Project, and Introduction to Tissue Mechanics.	Watch W1.2 - W1.5: Math Preliminaries Videos
27-Aug	Thur	Gleason	In-class examples and PSS 1: Tensors.	
1-Sep	Tues	Gleason	In-class PSS 1: Tensors. Pop quiz 1	Watch W2.1 - W2.5: Kinematics
3-Sep	Thur	Gleason	In-class PSS 1: Tensors.	
8-Sep	Tues	Gleason	In-class PSS 2: Kinematics (covers W1, Math Prelims). Pop quiz 2	Watch W3.1 - W3.3: Stress Videos
10-Sep	Thur	Gleason	In-class PSS 2: Kinematics & Quiz 1 (covers W1, Math Prelims).	
15-Sep	Tues	Gleason	In-class examples and PSS 3: Stress. Pop quiz 3	Watch W4.1-4.3: Balance Relations & Constitutive Behavior
17-Sep	Thur	Gleason	In-class PSS 3: Stress. Start review for Term Test 1.	
22-Sep	Tues	Gleason	In-class PSS on balance relations & start Review for Term Test 1.	Watch 5.1-5.4 Rivlin - Uniaxial
24-Sep	Thur	Gleason	Term Test 1 (covers Tensors, Kinematics, Stress)	
29-Sep	Tues	Gleason	In-class examples and PSS 4: Humphrey. Pop quiz 4	Watch 6.1-6.5: Blood Vessel Mechanics
1-Oct	Thur	Gleason	In-class PSS 4: Humphrey.	
6-Oct	Tues	NO CLASS - FALL BREAK		
8-Oct	Thur	Gleason	In-class examples and PSS 5: Fung. Pop Quiz 5	
13-Oct	Tues	Gleason	PSS 5: Fung.	TBD
15-Oct	Thur	Gleason	PSS 5: Fung & Quiz 2 (Balance relations + Rivlin) Paper approval.	
20-Oct	Tues	Gleason	PSS 5: Fung. Turn in " Quiz 3 " solution to Chuong & Fung	
22-Oct	Thur	Gleason	In-class & PSS on Special Topics - TBD	
27-Oct	Tues	Gleason	Review	TBD
29-Oct	Thur	Gleason	Term Test 2 (Humphrey, Chuong & Fung, TA-1)	
3-Nov	Tues	Gleason or TA	Special topics 1. Pre-presentation Consult with Dr. G	TBD
5-Nov	Thur	Gleason or TA		
10-Nov	Tues	TA	Special topics 2.	TBD
12-Nov	Thur	TA		
17-Nov	Tues	Gleason	Team Project Presentations	TBD
19-Nov	Thur	Gleason	Team Project Presentations	
24-Nov	Tues	Gleason	Team Project Presentations	
26-Nov	Thur	NO CLASS - THANKSGIVING		
1-Dec	Tues	Gleason	Special topics 3	
3-Dec	Thur	Gleason	Special topics 3	
8-Dec	Tues	Gleason	Review	
9-Dec	Tues	Gleason	Final Exam TBD	Final Exam