BMED 3410-A: Introduction to Biomechanics

Fall Term 2026

Credits: 3.0

Course instructors:

Section A01 **Dr. Costas Arvanitis**
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Section A02 **Dr. Denis**
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Teaching assistants:

Section A01 **Vivienne Zacher**
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Section A03 **Akshita Sahni**
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Office hours: Wednesdays 3:30 – 4:30 pm, BME Learning Commons

Meeting Times:

Lectures:

All sections Wednesday and Friday, 2:00-3:15 pm, D.M. Smith Bldg., Room: 115

Problem Solving Studio:

Section A01 Monday, 8:10-10:05 am, UAW 1214
Section A02 Monday, 10:25-12:20 pm, UAW 1214
Section A03 Monday, 12:30-2:25 pm, UAW 1214

Course Overview: This is an introductory course covering mechanics applied to biomedical engineering problems. The course provides students with basic concepts and approaches for solving deformation and dynamics problems relevant to biomedical applications. The course will focus on the application of simple models from statics, mechanics of materials, kinematics, and dynamics.

Prerequisites: Undergraduate Semester level MATH 2403 or MATH 2413 or MATH 2551 or MATH 2562 (Min D) or MATH 24X3 or MATH 2X52 (Min T) **and** COE 2001 (Min C)

Important Dates

August 24: First day of classes
September 7: Labor Day, Official Institute Holiday
October 5 & 6: Fall Break. No Classes
November 25: Student Recess. No Classes
November 26 & 27: Thanksgiving. Official Institute Holiday
December 17: End of Term
December 21: Grade submission deadline

Course Texts: We do not require a specific textbook for this course. However, in the past, the course has used the following textbooks, which may be helpful

- Humphrey, J. Delange S., An Introduction to Biomechanics: Solids and Fluids, Analysis and Design, Springer, 2004. (ISBN: 9781441923189)
- J.L. Meriam and R.G. Kraige, Engineering Mechanics: Dynamics, 14th ed. (or whatever edition you can get, John Wiley & Sons, Inc, 2002
- Hibbeler, R., Engineering Mechanics: Dynamics, 11th ed, Prentice Hall, 2006. (ISBN: 0131561480)]

Course Outcomes

Successful completion of this course will yield the following learning outcomes:

Outcome 1: Statics – stress, strain, and mechanical properties of materials.

1.1 Students will recall the key statics concepts.
1.2 Students will be able to draw free body diagrams (FBDs).

Outcome 2: Axial Loading – methods for finding the deformation of axially loaded materials.

2.1 Students will understand axial tension and compression stress concepts.
2.2 Students will apply FBDs to model axial loading conditions.
2.3 Students will be able to analyze strain of members under various axial loads.

2.4 Students will understand the pipeline of the model construction from geometry, material, and loading to stress, strain, and deformation.
2.5 Students will be able to solve axial loading problem with uniform and non-uniform geometry, material, and loads using graph-based integration.
2.6 Students will be able to apply displacement constraints and the principle of superposition to solve statically indeterminate problems.

Outcome 3: Torsion – methods for finding deformation of materials under torsional loading.

3.1 Students will understand the process of modeling shear stress and strain distributions based on geometry, materials, and torsional loading conditions.
3.2 Students will be able to estimate failure strength of structures using torsional analysis.

Outcome 4: Bending – methods for finding deformation of materials caused by bending.

4.1 Students will understand the pipeline of the model construction from geometry, material, and loading to internal stress, strain, and deformation.
4.2 Students will be able to solve loading problem using graph-based integration.
4.3 Students will master the technique for calculating area moments of inertia for complex cross-sections of bended beams.

Outcome 5: Dynamics – finding the effects of forces and torques on the motion of objects.

5.1 Students will understand the concept of the degree of freedom, resultant force, inertia, and acceleration.
5.2 Students will learn how to draw and use kinetic diagrams (KIN).
5.3 Students will be able to build kinematic and dynamic models to relate position, velocity, and acceleration of point mass in 1D and 2D, and describe planar motion of rigid bodies.
5.4 Students will be able to solve kinematic chain problems.
5.5 Students will learn how to calculate the rotational inertia using integration and the parallel axis theorem.
5.6 Students will be able to solve dynamics problems using D'Alembert's principle of inertial forces.

Course Website

BMED 3410-A will use Canvas: https://gatech.instructure.com/courses/538460 as the course website. The instructors and TAs will upload assignments, solutions, and other material on Canvas, and will regularly post announcements. Please check the site frequently for updated information.

Piazza

We will also use Piazza for class discussions. The system is highly catered to getting help fast and efficiently from classmates and the TAs. Rather than emailing questions to the teaching staff, we encourage you to post your questions on Piazza. We also encourage you to respond to questions of other students. When students help each other, piazza becomes very efficient and useful.
Find our class page at: https://piazza.com/class/mt07asca69j37p .

Grading Policy

Grades will be determined based on demonstrated proficiency on **homework quizzes, problem solving studios,** and **exams**. The points associated with each graded event are shown below.

Problem Solving Studio:	7.0% (fourteen sessions, 0.5 points each)
Homework Quizzes:	18.0% (six quizzes, 3 points each)
Midterm Exam 1:	16.0%
Midterm Exam 2:	16.0%
Midterm Exam 3:	16.0%
Final Exam:	27.0%

Your final grade will be assigned according to the accumulated score and the following cutoff values:

A ("Excellent"):	$\geq 85\%$
B ("Good"):	$\geq 75\%$
C ("Satisfactory"):	$\geq 60\%$
D ("Passing"):	$\geq 40\%$
F ("Failure"):	$< 40\%$

Homework Assignments

There will be a total of six (6) homework assignments. You will not submit your homework for grading, and you will have access to the homework answers. Nonetheless, we strongly recommend that you carefully work through the homework problems and do so without looking at the provided solutions until you have an answer about which you are confident. Doing the homework is the best way to do well at the associated homework quizzes.

Homework Quizzes

The homework quizzes will be designed to reward people who have done the homework. For each of the six (6) homework assignments, there will be an associated homework quiz on the day by which the homework should have been completed. These will be in-class quizzes for about 20-25 min at the end of lectures according the detailed schedule below. Each quiz will be given a grade between 0 and 100 points (scaled to give maximal 18 points for 6 quizzes). The quizzes will be designed such that people who have done the associated homework will be likely to perform well. Each quiz may be a modified version of a problem from the homework or a different problem of similar difficulty.

Problem Solving Studio

PSS will be graded based on the participation/contribution. No paper submissions will be required. Each session will be given a grade 0 or 0.5 (adding to maximal 7 points in total for 14 studios).

Course Schedule

The following lists all the topics covered in BMED 3410-A, a tentative schedule for quizzes and exams, and the corresponding points that determine the final grade (as outlined above).

Week	Date	Class	Topic	HW postir	Points
1	08/24	PSS 1	Introduction, Syllabus, Expectations		0.5
	08/26	Lecture 1 (Dr. Desai)	Point Mass	HW1	
	08/28	Lecture 2 (Dr. Desai)	Circular Motion		
2	08/31	PSS 2	Point Mass and Circular Motion Problems		0.5
	09/02	Lecture 3 (Dr. Desai)	Rigid Body Kinematics I		
	09/04	Lecture 4 (Dr. Desai)	Rigid Body Kinematics II		
3	09/07	No Class	Labor Day		
	09/09	Lecture 5 (Dr. Desai)	Rigid Body Kinematics III, HWQ1	HW2	3
	09/11	Lecture 6 (Dr. Desai)	Dynamics of Rigid Bodies I		
4	09/14	PSS 3	Rigid Body Kinematics Problems		0.5
	09/16	Lecture 7 (Dr. Desai)	Dynamics of Rigid Bodies II		
	09/18	Lecture 8 (Dr. Desai)	Review of Dynamics of Rigid Bodies, HWQ 2		3
5	09/21	PSS 4	Dynamics of Rigid Bodies Problems		0.5
	09/23	Exam 1	Kinematics and Dynamics Exam		16
	09/25	Lecture 9 (Dr. Arvanitis)	Static Equilibrium I		
6	09/28	PSS 5	Static Equilibrium Problems		0.5
	09/30	Lecture 10 (Dr. Arvanitis)	Simple Axial Loading I	HW3	
	10/02	Lecture 11 (Dr. Arvanitis)	Simple Axial Loading II		
7	10/05	No Class	Fall Break		
	10/07	Lecture 12 (Dr. Arvanitis)	Model of Axial Loading I		
	10/09	Lecture 13 (Dr. Arvanitis)	Model of Axial Loading II		
8	10/12	PSS 6	Axial Loading Problems I		0.5
	10/14	Lecture 14 (Dr. Arvanitis)	Model of Axial Loading III, HWQ 3	HW4	3
	10/16	Lecture 15 (Dr. Arvanitis)	Indeterminate Systems I		

9	10/19	PSS 7	Axial Loading Problems II		0.5
	10/21	Lecture 16 (Dr. Arvanitis)	Indeterminate Systems II		
	10/23	Lecture 17 (Dr. Arvanitis)	Review of Axial Loading and Indeterminate Systems, HWQ 4		3
10	10/26	PSS 8	Indeterminate Systems Problems		0.5
	10/28	Exam 2	Axial Loading Exam		16
	10/30	Lecture 18 (Dr. Denis)	Torsional Loading I	HW5	
11	11/02	PSS 9	Torsional Loading Problems I		0.5
	11/04	Lecture 19 (Dr. Denis)	Torsional Loading II		
	11/06	Lecture 20 (Dr. Denis)	Torsional Loading III		
12	11/09	PSS 10	Torsional Loading Problems II		0.5
	11/11	Lecture 21 (Dr. Denis)	Model of Bending I, HWQ 5	HW6	3
	11/13	Lecture 22 (Dr. Denis)	Model of Bending II		
13	11/16	PSS 11	Model of Bending Problems I		0.5
	11/18	Lecture 23 (Dr. Denis)	Model of Bending III		
	11/20	Lecture 24 (Dr. Denis)	Model of Bending IV, HWQ 6		3
14	11/23	PSS 12	Model of Bending Problems II		0.5
	11/25	Holiday	Student Recess		
	11/27	Holiday	Thanksgivings		
15	11/30	PSS 13	Model of Bending Problems III		0.5
	12/02	Lecture 25 (Dr. Denis)	Indeterminate Systems for Torsion and Bending		
	12/04	Exam 3	Torsion and Bending Exam		16
16	12/07	PSS 14	Review of the Course Material		0.5
17	TBD	Final Exam	Cumulative Exam		27
18	12/21		Grade submission due		

Course Policies

The following are policies meant to promote a fair and productive learning environment for all students. Please feel free to ask any questions you may have about these policies.

- **Grade Disputes/Reviews**: Please note that students' final grades will be based solely on the collected points as outlined above. Regrettably, to do otherwise would be arbitrary and unfair; Accordingly, requests from students to be allowed to submit supplemental material after the end of term to increase their grades cannot be entertained. Similarly, requests to arbitrarily increase student grades for personal reasons cannot be entertained.
- **Late/Delayed Assignments**: Students who are absent because of participation in a particular religious observance will be permitted to make up the work missed during their absence with no late penalty, provided the student informs the course instructor of the upcoming absence, in writing, within the first two weeks of class, and provided the student makes up the missed material within the timeframe established by the course instructor.

  Students who are absent because of participation in approved Institute activities (e.g. field trips and athletic events) will be permitted to make up the work missed during their absences. Timing of the missed assignment turn-in will be determined by the instructor.
- **Collaboration**: Although you are encouraged to study together, all of your quizzes and exams must be your own original work. You must take all of your quizzes and exams using only a primitive writing utensil (pencil or pen) and the materials provided to you for the quiz or exam by the class TAs and instructors. You also are not allowed to communicate in any way with people other than the class TAs and instructors during a quiz or exam. Likewise, you are not allowed to look at the work of other students during a quiz or exam. Any violations will be prosecuted through the Office of Student Integrity. See *Academic Integrity* section for additional info.
- **Individuals with Special Needs:** If you are a student with learning needs that require special accommodation, contact the Office of Disability Services (often referred to as ADAPTS) 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. Also, please e-mail your instructor as soon as possible in order to set up a time to discuss your learning needs.

Additional Instruction and Class Discussion

Supplemental instruction by the instructor or TA is a valuable resource available to any student having difficulty with a particular concept in the course. Get help when you have a problem! **Students are highly encouraged to attend office hours or make an appointment via email.**

Academic Integrity

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor, and your compliance with Georgia Tech's Academic Honor Code (www.honor.gatech.edu) is fully expected. Any evidence of cheating will be referred to the Dean of Students for a review, along with a recommendation of a zero grade for the assignment/exam in question and a full letter grade reduction for the course grade.

Honor code violations include, but are not limited to, the following:

- **Unauthorized Access**: Possessing, using, or exchanging improperly acquired written or verbal information in the preparation of a problem set, laboratory report, essay, examination, or other academic assignment.
- **Plagiarism**: Submission of material that is wholly or substantially identical to that created or published by another person(s), without adequate credit notations indicating the authorship.
- **False Claims of Performance**: False claims for work that has been submitted by a Student.
- **Grade Alteration**: Alteration of any academic grade or rating so as to obtain unearned credit.
- **Deliberate Falsification**: Deliberate falsification of a written or verbal statement of fact to a Faculty member and/or Institute Official, so as to obtain unearned academic credit.

Student-Faculty Expectations

At Georgia Tech we believe that it is important to continually strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. See http://www.catalog.gatech.edu/rules/22.php for an articulation of some basic expectations – that you can have of us, and that we have of you. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, we encourage you to remain committed to the ideals of Georgia Tech, while in this class.

Consent to participate in research

You may be asked to participate in educational research while enrolled in this course in the form of interviews, observations, questionnaires, or surveys, helping the BME department gain a deeper understanding of and promote practices that increase inclusivity within the classroom. Participation in this project in completely voluntary, anonymous, and has minimum to no risk. Participation in this research will not affect your grade in any way, and you may withdraw from the research at any point. If you agree to participate, you will need to read, sign, and return a consent form that you will receive from your instructor.

Special Notes for BMED 3410 in Fall 2022 due to Covid-19

For the most resent updates, please refer to
https://health.gatech.edu/coronavirus/institute-operations

CARE Center, Counseling Center, Stamps Health Services, and the Student Center

These uncertain times can be difficult, and many students may need help in dealing with stress and mental health. The **CARE Center** and the **Counseling Center**, and **Stamps Health Services** will offer both in-person and virtual appointments. Face-to-face appointments will require wearing a face covering and social distancing, with exceptions for medical examinations. Student Center services and operations are available on the **Student Center** website. For more information on these and other student services, contact the Vice President and Dean of Students or the **Division of Student Life**.