

BME 6938: Computational Methods in Musculoskeletal Biomechanics

Fall 2023

Day	Block	Time	Location
Monday	5	11:45 am – 12:35 pm	COMM C1-004
Wednesday	5 & 6	11:45 pm – 1:40 pm	COMM C2-033

Instructor

Jennifer A. Nichols, Ph.D.

Assistant Professor

J. Crayton Pruitt Family Department of Biomedical Engineering

Herbert Wertheim College of Engineering

jnichols@bme.ufl.edu

Office Hours: To be determined. See Canvas for details.

Course Description

This course will examine on how rigid body dynamics can be used to study the musculoskeletal system. Emphasis will be placed on computational methods for analyzing human movement, such as forward dynamic simulations, inverse dynamic simulations, and musculoskeletal modeling.

Course Pre-Requisites / Co-Requisites

There are no required pre-requisites or co-requisites. However, an understanding of kinematics, kinetics, statics, dynamics, and basic coding skills will be useful.

Course Objectives

By the end of this course, students should be able to do the following:

- Describe the musculoskeletal system using anatomical and mathematical terms
- Construct rigid body musculoskeletal computer models
- Analyze and interpret forward and inverse simulations of human movement
- Critically read and discuss the biomechanics literature in order to identify and understand computational methods to evaluate musculoskeletal biomechanics

Materials and Supply Fees

None.

Required Textbooks and Software

Required Textbooks

Course notes and assigned readings are derived from various published sources and professional records of the course instructor. These materials will be distributed through the course website on Canvas.

Required Software

Opensim, an open-source musculoskeletal software program, will be used for homework assignments. This software runs on Windows and Mac computers, and is freely available at <https://simtk.org/projects/opensim>

Matlab or Python will be required for some homework assignments and the computational project.

Recommended Materials

The following are useful reference texts:

- *Title:* Biomechanics of Movement: The Science of Sports, Robotics, and Rehabilitation
Author: Thomas Uchida & Scott Delp
Publisher: MIT Press
Date & Edition: 2021, 1st Ed.
ISBN: 978-0262044202
Website: <https://simtk-confluence-homeworks.stanford.edu:8443/display/BMH>
- *Title:* Biomechanics and Control of Human Movement
Author: David A. Winter
Publisher: Wiley
Date & Edition: 2009, 4th Ed.
ISBN: 978-0-470-39818-0
- *Title:* Atlas of Human Anatomy
Author: Frank H. Netter
Publisher: Saunders Elsevier
Date & Edition: 2014, 6th Ed.
ISBN: 978-1455704187

or any other good atlas of human anatomy

Course Schedule

Note: The course schedule is subject to change. Please refer to the course website for current schedule.

- Week 1: Introduction to Musculoskeletal Biomechanics
- Week 2: Bones, Joints, & Equations of Motion
- Week 3: Muscle Models
- Week 4: Musculoskeletal Geometry
- Week 5: Inverse Dynamics
- Week 6: Forward Dynamics
- Week 7: Optimization & Control
- Week 9 – 15: Student-Driven Topics*
- Week 16: Summary & Final Review

*During the first two week of class, students will be provided a list of contemporary topics in computational biomechanics. Through a selection process, students will choose the topics most relevant and interesting to their professional goals. These topics will be covered through a combination of instructor-led lectures and student-led literature presentations throughout the second half of the semester. Sample topics include finite element analysis, induced acceleration analysis, analysis of wearable data, direct collocation and applications of optimal control, applications of machine learning to biomechanics, movement analysis for clinical assessments, etc.

Course Policies

Attendance Policy, Class Expectations, and Make-Up Policy

Class: Students are expected to attend scheduled class sessions. Attending class is critical for understanding the course material, as there is no textbook. Class sessions will regularly include presentation of new material, solving sample problems, answering questions, and discussion. Students who are regularly absent from class (defined as 6 or more unexcused absences) will receive a zero for their participation grade. Excused absences must be consistent with university policies in the Graduate Catalog (<https://catalog.ufl.edu/graduate/regulations>) and require appropriate documentation. Additional information can be found here: <https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/>

Participation: Students are expected to engage with the course material both inside and outside of class. The participation grade reflects in-class activities and assignments. The highest marks are regularly given to students that come to class having read all of the assigned materials and are prepared to actively discuss them.

Homework: Homework assignments provide students with an opportunity to apply concepts learned in class and affirm their understanding of the course material. All assignments should be turned in electronically via the course website. Please use the following convention when naming your homework files: LastName_HW_X.pdf (replace “LastName” with your last name and “X” with the homework number). Assignments turned in late will not be graded, except under extreme circumstances at the discretion of the instructor. Students are encouraged to work cooperatively on assignments. However, each student must individually submit assignments consisting of his or her own work. This means that students are encouraged to discuss the solution process for problems. However, copying another student’s work (or allowing a student to copy your work) will be considered a violation of the University honor code.

Exams: Exams are an opportunity for students to demonstrate their mastery of course concepts. There will be one cumulative exam. Students are expected to be present for exams. Students who miss an exam due to an illness or emergency and who provide proper documentation of the excused absence will take a make-up for full credit as soon as possible after original exam date.

Literature Presentation: The literature presentations are an opportunity for students practice critically evaluating the literature, presenting, and leading discussion. Students will work in small groups to present two or three papers. Further details will be discussed in class and distributed on the course website.

Project: The project allows students to gain an in-depth understanding of a biomechanics topic of their choice. Further details on the project will be discussed in class and distributed on the course website.

Re-Grade Policy: If a student feels that an assignment or exam was graded incorrectly, they should return the assignment and a written description of the grading error to the instructor within 5 business days of receiving the graded assignment. The instructor will evaluate the request and adjust the grade if an error was made. Any request for re-grading where the student has altered the assignment after it was returned to gain a grade benefit will be considered a violation of the University honor code.

Changes to the Syllabus: Occasionally, course policies may need to be changed due to unforeseen circumstances or to improve the course. The instructor reserves the right to make necessary changes. Additionally, if a student or group of students have a suggestion on how to revise the course and the instructor agrees that the revision would improve the course, the proposed change will be put to an anonymous vote by the entire class. If the majority of the class agrees to the change, it will become part of the syllabus.

Evaluation of Grades

Assignment	Percentage of Final Grade
Homework	15%
Literature Presentation	30%
Project	30%
Final Exam	20%
Participation	5%
	100%

Grading Policy

Grade	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	E
Percent	93.4 - 100	90.0 - 93.3	86.7 - 89.9	83.4 - 86.6	80.0 - 83.3	76.7 - 79.9	73.4 - 76.6	70.0 - 73.3	66.7 - 69.9	63.4 - 66.6	60.0 - 63.3	0 - 59.9
Grade Points	4.00	3.67	3.33	3.00	2.67	2.33	2.00	1.67	1.33	1.00	0.67	0.00

More information on UF grading policy may be found at:

[UF Graduate Catalog](#)

[Grades and Grading Policies](#)

Relevant University Policies

Students Requiring Accommodations

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting <https://disability.ufl.edu/students/get-started/>. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.ua.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.ua.ufl.edu/public-results/>.

In-Class Recording

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A “class lecture” is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To “publish” means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript

of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

University Honesty Policy

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (<https://sccr.dso.ufl.edu/process/student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values varied perspectives and lived experiences within our community and is committed to supporting the University's core values, including the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of race, creed, color, religion, age, disability, sex, sexual orientation, gender identity and expression, marital status, national origin, political opinions or affiliations, genetic information, and veteran status.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- HWCOE Human Resources, 352-392-0904, student-support-hr@eng.ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

Campus Resources

Health and Wellness

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: <https://counseling.ufl.edu>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu.
<https://lss.at.ufl.edu/help.shtml>.

Career Connections Center, Reitz Union, 392-1601. Career assistance and counseling; <https://career.ufl.edu>.

Library Support, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.
<https://teachingcenter.ufl.edu/>.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers.
<https://writing.ufl.edu/writing-studio/>.

Student Complaints Campus: <https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>; <https://care.dso.ufl.edu>.

On-Line Students Complaints: <https://distance.ufl.edu/getting-help/>; <https://distance.ufl.edu/state-authorization-status/#student-complaint>.