MAE 263F: Mechanics of Flexible Structures and Soft Robots

University of California, Los Angeles

Department of Mechanical and Aerospace Engineering

Los Angeles, CA 90095

Syllabus, Fall 2025

Instructor

Professor M. Khalid Jawed khalidjm@seas.ucla.edu Office: Boelter 3731-G
Office Hours Monday 2 – 3 pm (or by appointment: khalidjm@seas.ucla.edu)

Lectures

Monday and Wednesday 12 pm - 1:50 pm Boelter 9436

Prerequisites

Programming experience

Class Website

https://bruinlearn.ucla.edu/courses/216502/

Slack

Please make sure to join our slack channel for discussions and announcements.

Grading

Homework (x 3)	50%
Project proposal and 5-minute presentation	5%
Mid-term progress report and 5-minute presentation	5%
Final project report	20%
Final presentation (20 minutes)	20%

In-person Instruction

The course will be offered in-person.

Collaboration, Exams, and Lateness Policy

Homework, reports, and codes must be written by the student in full. Collaboration and discussion with the instructor and other students are encouraged. If you use any code that you did not write yourself, you must cite the source as a comment in your submitted code as well as in the accompanying report. This also means that you must cite the materials (codes and notes) that are available to you via BruinLearn. In case of acceptable emergencies, any reasonable accommodation as requested by the appropriate UCLA office will be made.

Assignment guidelines

You are required to use one of the following two templates:

- LaTeX template (highly recommended) http://ras.papercept.net/conferences/support/tex.php
- MS Word template http://ras.papercept.net/conferences/support/word.php

Page limit:

- Homeworks: no page limit.
- Project proposal: max. 4 pages (excluding bibliography)
- Mid-term progress report: max. 5 pages (excluding bibliography)
- Final project report should be formatted as a journal article or a peer-reviewed conference paper.

Proposal, progress report, and final report must include a bibliography in an acceptable format (e.g., APA). At a minimum, your proposal and progress report should include **5 references**. Final report should include at least **10 references**.

GitHub repository

- Create a (private or public) repository on github.com and upload all of your work (codes, reports, presentations) to the repository. It is recommended that you start with a private repository (share it with the instructor: khalidjm@seas.ucla.edu). Depending on the quality and progress of your work, you can make the repository public and contribute to the open-source community.
- You are encouraged (not required) to create a website to showcase your work. This can also serve as part of your professional portfolio. Several platforms offer free web design and hosting services, e.g., GitHub Pages, Google Sites, WordPress, etc.

Textbooks and resources

No required textbook. List of useful books and papers:

Useful resources on the mechanics of slender elastic structures

- Jawed, M. K., Novelia, A., and O'Reilly, O. A primer on the kinematics of discrete elastic rods. Springer-Verlag, 2018.
    - This book is available for free via CCLE.
- Audoly, Basile, and Yves Pomeau. Elasticity and geometry: from hair curls to the nonlinear response of shells. Oxford University Press, 2010.
- Course notes for "2.081J/16.230J Plates and Shells" (MIT) by Tomasz Wierzbicki https://dspace.mit.edu/handle/1721.1/45585

Rods

- Bergou, M., Wardetzky, M., Robinson, S., Audoly, B., & Grinspun, E. (2008). Discrete elastic rods. *ACM transactions on graphics*, 27(3), 63.
- Bergou, M., Audoly, B., Vouga, E., Wardetzky, M., & Grinspun, E. (2010). Discrete viscous threads. *ACM transactions on graphics*, 29(4), 116.

Plates and shells

- Baraff, D., & Witkin, A. (1998, July). Large steps in cloth simulation. *Proceedings of the 25th annual conference on Computer graphics and interactive techniques* (pp. 43-54).
- Grinspun, E., Hirani, A. N., Desbrun, M., & Schröder, P. (2003, July). Discrete shells. In *ACM SIGGRAPH/Eurographics symposium on Computer animation* (pp. 62-67).
- Note: several implementations of plate/shell simulations (typically used for cloth simulation in graphics) are available online, e.g., http://davidpritchard.org/freecloth/

Contact, Constrained Lagrangian Mechanics

- Goldenthal, R., Harmon, D., Fattal, R., Bercovier, M., & Grinspun, E. (2007, August). Efficient simulation of inextensible cloth. *ACM Transactions on Graphics*, 26(3), 49.
- Spillmann, J., & Teschner, M. (2008, April). An adaptive contact model for the robust simulation of knots. *Computer Graphics Forum,* 27(2), 497-506.

Machine Learning

- Textbook: Pattern recognition and machine learning (recommended by not required). Christopher Bishop.
- Introductory Coursera Course by Andrew Ng: https://www.coursera.org/specializations/machine-learning-introduction
- Chen, R.T., Rubanova, Y., Bettencourt, J. and Duvenaud, D.K., 2018. Neural ordinary differential equations. *Advances in neural information processing systems*, 31.

Tentative lecture and homework schedule

Fall 2025

Date	In-person/ Zoom	Lecture number and topic	Due
M 09/29/2025	In-person	Lecture 1: Newton's method, Simulation of Mass-Spring-Damper System (Chapters 1-2)	
W 10/01/2025	In-person	Lecture 2: Simulation of Multi-Mass-Spring-Damper System, Conservative Force and Potential Energy (Chapters 3-4)	
M 10/06/2025		Lecture 3: Conservative Force and Potential Energy (Chapters 3-4), Discrete Simulation of an Elastic Beam	
W 10/08/2025	In-person	Lecture 4: Discrete Simulation of an Elastic Beam, Discrete Twist (Chapters 5-6)	
M 10/13/2025	In-person	Lecture 5: Discrete Simulation of an Elastic Beam, Discrete Twist (Chapters 5-6)	
W 10/15/2025	In-person	Lecture 6: Discrete Elastic Rods Algorithm (Chapter 7)	Homework 1
M 10/20/2025	In-person	Lecture 7: Discrete Elastic Rods Algorithm (Chapter 7)	
W 10/22/2025	In-person	Lecture 8: Discrete Elastic Rods Algorithm (Chapter 7)	
M 10/27/2025	In-person	Lecture 9: Discrete Elastic Plates & Shells (Chapter 8)	Homework 2
W 10/29/2025	In-person	Lecture 10: Discrete Elastic Plates & Shells (Chapter 8)	
M 11/03/2025	In-person	Lecture 11: Project Proposal Presentation	Project Proposal
W 11/05/2025	In-person	Lecture 12: Predictor Corrector Method	Homework 3
M 11/10/2025	**Zoom**	Lecture 12: Predictor Corrector Method **Zoom: https://ucla.zoom.us/j/92153417264**	
W 11/12/2025	In-person	Lecture 14: Modified Mass Method; Fluid-Structure Interaction	
M 11/17/2025	In-person	Lecture 15: Neural Networks (Chapter 9)	Homework 4
W 11/19/2025	In-person	Lecture 16: Neural Ordinary Differential Equations (Chapter 9)	
M 11/24/2025	In-person	Lecture 17: Mid-term presentation	Mid-term Report and Presentation
W 11/26/2025	**Zoom**	Lecture 18: Final project discussion **Zoom: https://ucla.zoom.us/j/92153417264**	Homework 5
M 12/01/2025	In-person	Lecture 19: Final project discussion	
W 12/03/2025	In-person	Lecture 20: Final presentation	Final Report is due on Saturday 12/06/24 at 11:59pm

University Policies and Support for Students

Academic Integrity

UCLA is a community of scholars. In this community, all members including faculty, staff and students alike are responsible for maintaining standards of academic honesty. As a student and member of the University community, you are here to get an education and are, therefore, expected to demonstrate integrity in your academic endeavors. You are evaluated on your own merits. Cheating, plagiarism, collaborative work, multiple submissions without the permission of the professor, or other kinds of academic dishonesty are considered unacceptable behavior and will result in formal disciplinary proceedings usually resulting in suspension or dismissal. See the Dean of Students website. for more information.

[source: Dean of Students syllabus statement (syllabus)]

Accommodations for Students with Disabilities

If you are already registered with the Center for Accessible Education (CAE), please request your Letter of Accommodation in the Student Portal. If you are seeking registration with the CAE, please submit your request for accommodations via the CAE website. Students with disabilities requiring academic accommodations should submit their request for accommodations as soon as possible, as it may take up to two weeks to review the request. For more information, please visit the CAE website, visit the CAE at A255 Murphy Hall, or contact us by phone at (310) 825-1501.

[source: Center for Accessible Education (Faculty Questions)]

Resources for Students

UCLA provides resources if you are feeling overwhelmed and need personal and/or academic assistance.

Please see the Red Folder for more information.

Title IX

Advocacy and Confidential Services:

Please note that Title IX prohibits gender discrimination, including sexual harassment, domestic and dating violence, sexual assault, and stalking. If you have experienced sexual harassment or sexual violence, you can receive confidential support and advocacy at the CARE Advocacy Office for Sexual and Gender-Based Violence, 205 Covel Commons, Los Angeles, CA, 90095, care@careprogram.ucla.edu, (310) 206-2465. Counseling and Psychological Services (CAPS) provides confidential counseling to all students and can be reached 24/7 at (310) 825-0768.

Reporting and Non-confidential Services:

Your professor is required under the UC Policy on Sexual Violence and Sexual Harassment to inform the Title IX Coordinator should he become aware that you or any other student has experienced sexual violence or sexual harassment. In addition, you can also report sexual violence or sexual harassment directly to the University's Title IX Coordinator, 2255 Murphy Hall, titleix@equity.ucla.edu, (310) 206-3417. Reports to law enforcement can be made to UCPD at (310) 825-1491.