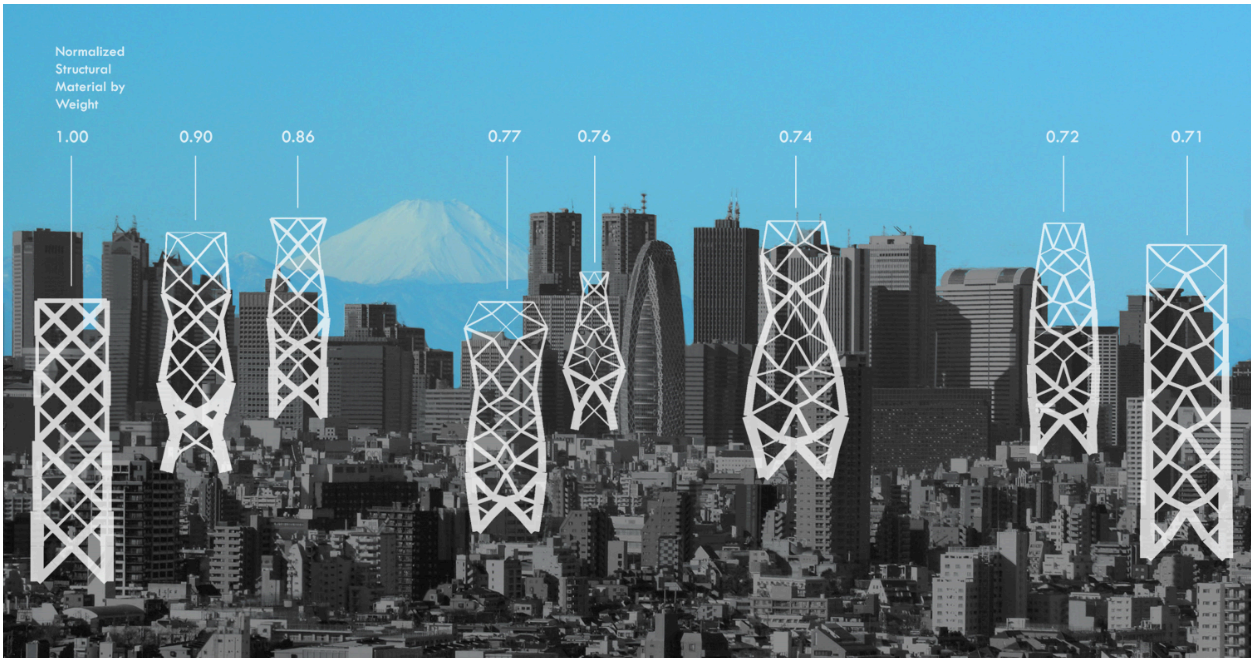
4.450J/1.575J/4.451 Computational Structural Design and Optimization // Fall 2026
Instructor: Caitlin Mueller // TA: Adam Burke



Subject Description
This research seminar focuses on cutting-edge applications of computation for creative, early-stage structural design and optimization for architecture. Topics covered include computational design fundamentals, including problem parameterization and formulation; design space exploration strategies, including interactive, heuristic, and gradient-based optimization; and computational structural analysis methods, including the finite element method, graphic statics, and approximation techniques. A range of historical and contemporary examples of structural optimization in theory and practice are introduced and investigated as case studies. Students will also complete semester-long individual research projects, which will focus on the development, implementation, or application of an innovative computational approach for structural design.

Instructor
Caitlin Mueller, Associate Professor
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Teaching Assistant
Adam Burke, BT PhD candidate
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Meeting Times
Lecture: Wednesday, 2-5pm in W41-1216

Textbook
Readings will be provided via Canvas website

Units and Level
3-0-9 Undergraduate (4.451)
3-0-9 Graduate (4.450J/1.575J)

Office Hours
Mondays 4:00-6:00 PM, W41-5510

Subject Canvas Website
https://canvas.mit.edu/courses/40135

Subject Slack Workspace
mit-4-451-f2026.slack.com

Learning Objectives
After successfully completing this subject, students will gain the following knowledge, skills, and abilities:

- Understand the general context and history of structural optimization in the field of building design.
- Distinguish between types of structural optimization approaches (size, geometry, topology) and generalized optimization methods and algorithms, and make informed decisions about when to use which approach and method.
- Formulate rich design spaces that contain diverse and interesting solutions through variable selection/reduction, bound and constraint setting, and definition of relevant performance objective(s).
- Apply contemporary structural optimization and design space exploration methods to realistic design problems using one or more commercial software or programming environments.
- Visualize optimization and design space exploration results in meaningful, multivariate graphic representations.
- Contribute to the research field of structural computation and optimization through the development, implementation, and/or application of the techniques introduced in the class.
- Explore the potential of computational design in circular architecture and construction.

Subject Meeting Structure and Interaction
In Fall 2026, all class meetings will be in person, unless otherwise announced. Attendance and participation are mandatory and evaluated as part of the semester grade (see below). Class meetings will include lecture, discussion, collaborative problem solving, and software tutorials. Additional asynchronous interaction related to class content will be available on Slack.

Office Hours and Questions
Meetings with the instructor will be by appointment, but class-related questions should first be directed to the TA in office hours and/or on Slack. The TA will hold a weekly two-hour period in person (or on Zoom if necessary) for students to come and ask questions about the class's content, assignments, etc. There will also be ample opportunities to ask questions in class. Students are asked to be respectful of the TA's schedule and should prepare questions in advance of deadlines. The TA will not be able to respond promptly outside of business hours, on weekends, etc.

Assignments and Project
The central focus of this subject is a semester-long original research/design project, supported by four preliminary homework assignments, weekly readings, in-class quizzes, and class discussions. Work is to be completed individually unless other arrangements are made. Late assignments will result in a reduction of one letter grade per day after the deadline unless extreme circumstances warrant an extension (must be arranged with TA 24 hours before the deadline). All assignments must be typed and submitted as a .pdf on Canvas.

Evaluation Criteria + Grading Breakdown

10% Attendance and Participation: Students are expected to attend the full session of each class and to actively contribute to the intellectual atmosphere via discussions, in-class exercises, Slack discussions, and general participation. Unexcused absences and/or non-participation will result in a grade reduction.

15% Assignments: Four homework assignments must be submitted via the Canvas site in approximately the first half of the term. At least six possible assignments will be distributed, and students may choose to submit four. If more are completed, the best four grades will be counted.

30% Quizzes: Each class there will be a short quiz to evaluate your learning and understanding of the course content. You will need a calculator and a pencil for the quizzes. Use of AI models is strictly prohibited when taking the quiz. Grading will be VLM assisted; however we will be manually auditing all answers marked as incorrect. Points may be recovered (75%) by meeting with your TA and demonstrating comprehension. The worst quiz score will be dropped (absent will be dropped).

10% Final Project Milestones: Two interim milestones (5% each) for the final project will be distributed and submitted via the Canvas site for evaluation of preliminary progress.

10% Final Project Presentation: Students will each give a 10-minute research presentation highlighting the key contributions of their final projects. Evaluation will consider both the content and the quality/clarity of the presentation.

25% Final Project Paper: The main deliverable for the course is the final research paper, which clearly and concisely presents the original research work completed during the course. The paper should be written in the style of a scholarly, technical academic publication that could be presented at a conference or submitted to a journal. The evaluation will consider creativity of the project concept, technical originality, scholarly quality, technical accuracy, and thoroughness of results. More information about the final project will be distributed later in the term.

Office Hours
Meetings with the instructor will be by appointment. The TA will hold a weekly two-hour period for students to come and ask questions about the class's content, assignments, etc.

Absence Policy
Attendance and participation are mandatory and part of this subject's grade (10%).

AI Policy
Unrestricted GenAI Use: Students may use any GenAI system for any purpose on assignments in this course with the exception of on in class quizzes. It is unlikely that current AI models will be able to complete all of the assignments due to the high level of spatial reasoning required for their execution. Fundamentally, you are responsible for the accuracy of everything you submit.

The in class quizzes serve to assist us in evaluating your independent understanding of the course material so it is important that these are AI free.

Academic Integrity + Honesty
MIT's expectations and policies regarding academic integrity should be read carefully and adhered to diligently: http://integrity.mit.edu

Semester Schedule

Week	Date	Lecture Topic	Assignments + Project
01	09/09	Introduction	
02	09/16	Classical Structural Optimization I: Analytical Methods	HW 01 Assigned
03	09/23	Classical Structural Optimization II: Numerical Methods	HW 02 Assigned
04	09/30	Structural Modeling and Performance Evaluation	HW 01 Due
05	10/07	Digital Circularity and Algorithmic Stock Assignment	HW 02 Due, HW 03 Assigned
06	10/14	Formulating, Exploring, Visualizing the Design Space	HW 04 Assigned, Project Assigned
07	10/21	Multi-Objective and Interactive Optimization	HW 03 Due, HW 05 Assigned
08	10/28	Form-Finding and Optimization of Surface Structures	HW 04 Due, HW 06 Assigned
09	11/04	Interim Project Presentations	Project Milestone 1 Due
10	11/11	No Class	HW 05 Due
11	11/18	Grammars, Combinatorics, and Discrete Assemblies	HW 06 Due
12	11/25	Optional Project Meetings (on Zoom)	
13	12/02	Tools for Creative Design and Semester Summary	Project Milestone 2 Due
14	12/09	Final Project Presentations I	
Finals	TBD	Final Project Presentations II*	Final Paper Due

** Half of final project presentations will occur in Final Exam Week, with the exact date determined by MIT around the third week of classes. Participation at the final project presentations is mandatory.*