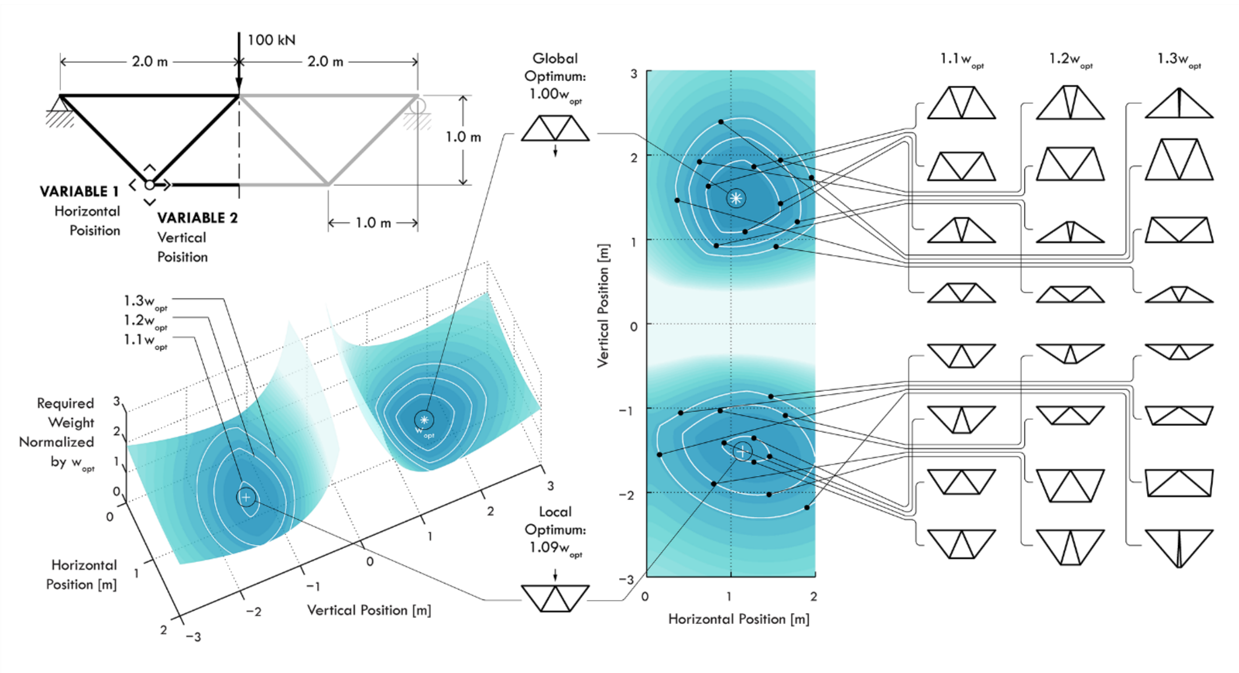
Course Overview



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. Enrollment limited.

Instructor

Caitlin Mueller, Room 5-421, caitlinm@mit.edu

Teaching Assistant

Pierre Cuvilliers, Room 5-414, pcuvil@mit.edu

Prerequisites

At least one subject in structural mechanics (4.440J/1.056J or 4.462 or equivalent) and programming experience.

Meeting Times

Lecture: Friday, 9am-12pm, Room 9-354
Office Hours: To be determined

Level

G (Advanced undergraduates welcome with permission)

Units

3-0-6 and 3-0-9. The 12-unit version will involve extra work on assignments and the project.

Learning Modules Website

https://learning-modules.mit.edu/class/index.html?uuid=/course/4/fa16/4.450#info

Textbook + Readings

Readings will be assigned in class on a weekly basis and made available through Stellar.

4.450: Computational Structural Design and Optimization
Instructor: Caitlin Mueller, TA: Pierre Cuvilliers // Fall 2016

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 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 methods to realistic design problems using one or more commercial software or programming environment.
- Visualize optimization and design space exploration results in meaningful, multivariate graphic representations.
- Contribute in the research field of structural computation and optimization through development, implementation, and/or application of the techniques introduced in the class.

Assignments and Project

The central focus of this subject is a semester-long original research project, supported by three preliminary homework assignments, weekly readings, 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 instructor 24 hours before deadline).

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, and general participation. Unexcused absences and/or non-participation will result in grade reduction.

45% Assignments: Three preliminary assignments (15% each) will be distributed and submitted via the Stellar site in approximately the first half of the term.

10% Final Project Milestones: Two interim milestones (5% each) for the final project will be distributed and submitted via the Stellar 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. Evaluation will consider originality, scholarly quality, technical accuracy, and thoroughness of results. More information about the final project will be distributed later in the term.

Academic Integrity + Honesty

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

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Course Schedule

WEEK	DATE	LECTURE TOPIC	ASSIGNMENTS + PROJECT
01	Sept. 9	Introduction	
02	Sept. 16	Classical Structural Optimization I: Analytical Methods	HW1 Assigned
03	Sept. 23	No Class (Career Fair)	
04	TBA	Classical Structural Optimization II: Numerical Methods	Project Assigned
05	Oct. 7	Form-Finding and Optimization of Surface Structures	HW1 Due, HW2 Assigned
06	Oct. 14	Problem Formulation: The Design Space	
07	Oct. 21	Interactive Optimization	HW2 Due
08	Oct. 28	Multi-Objective Optimization	HW3 Assigned
09	Nov. 4	Interim Project Presentations	Project Milestone 1 Due
10	Nov. 11	No Class (Veterans' Day)	HW3 Due
11	Nov. 18	Visualization of the Design Space and the Objective Space	
12	Nov. 25	Thanksgiving Break: No Class	Project Milestone 2 Due (Optional)
13	Dec. 2	Creative Computation and the Future of Optimization	Project Milestone 2 Due (Required)
14	Dec. 9	Final Project Presentations I	Final Paper Draft Due
15	Finals Wk	Final Project Presentations II	Optional Updated Paper