CIVE 546 Course Project

Objectives:

- Perform structural optimization of any structures of your choice, experience the full process, and provide meaningful discussions
- Give a **7-minute** PechaKucha-style PowerPoint presentation of your project to the class and respond to questions from the audience. Guidelines for the presentation are attached at the end.

Submissions:

1. [Preliminary Approval] For Paths 2&3, preliminary approval must be obtained from the instructor by **02/11/25.**
2. [Milestone] Upload the topic you have selected by the end of Monday**, 03/11/25** on myCourses. The milestone should include the description of background and selection of program/software. If a team is formed, please include task divisions in the milestone.
3. The project presentations will be held near the end of semester. The exact date and time will be announced. Project report will be due one week after the presentations. Each day of late submission will lead to 25% reduction in the total project score.

Assignment:

Perform structural optimization of any structures of your choice. There are no restrictions on the materials as long as the results are meaningful to Civil or Mechanical Applications. The structure can be of various scales, from material-level (e.g., structure for metamaterials, negative Poisson's ratio material), to component scale (e.g., beams, columns, roof), and system (e.g., lateral-force-resisting system of building, truss layout of truss bridges). You may also choose to optimize across scales (e.g., material and component simultaneously).

There are three paths you can select:

1. (Individual) Optimize any structures of your choice. You can use any existing topology optimization programs (e.g., in MATLAB, ANSYS, ABAQUS). You will be asked to fabricate a demonstration model of your optimized structures (e.g., using 3D printing or by hand). A 3D printing guide will be posted in MyCourses shortly. You are encouraged to be creative in using other materials and fabrication methods.
2. (A team of 2 students) Optimize a simply-supported truss bridge. You can use any existing topology optimization programs (e.g., in MATLAB or ABAQUS) and choose your testing protocol. You will be asked to design, fabricate, and test a conventional design for comparison. You will need to fabricate a reduced-scale model and then test on using weights under a simply-supported option. Fabrication and testing may follow a Spaghetti fabrication and tests.
3. (Individual or a team of 2 students) Optimize any structures of your choice. You write your own optimization program (no need to be restricted to topology optimization). You need to justify the necessity of using an optimization algorithm for the selected topic. No need to fabricate.

Supplementary rules:

- Graphic statics may be used to supplement the discussion but should not be used as the primary design tool.
- Please actively discuss with the instructor about your topic (as early as possible). For path 2&3, you need to inform your instructor of your team composition and selected topic before **02/11/2025**.
- The students are responsible for the fabrication process, including material ordering. For Path 2,

the students need to determine the fabrication process and loading methods, which must be included in the milestone and approved by the instructor.

Content and Grading (out of the total 20% course grades):

Module	**Weight**	**Content**
Background	3%	Brief discussion of design background, current state-of-the-art designs, typical loading patterns (e.g., types and locations), typical support patterns (e.g., types and locations), typical spatial constraints for the problem. Have any optimization techniques already been adopted for this type of problem (if so, provide a brief review)?
Problem setting	2%	How did you simplify the typical patterns into the optimization problem setting (e.g., loading, supporting, spatial constraints). What are the considerations (e.g., probability, magnitude)?
Optimization	5%	Description of the optimization software/program, their assumptions, objective functions, material models, constraints, and applicability to your problem. Discuss the appropriateness and any discrepancies (e.g., does the material model accurately describe your material, does the objective function truly represent all the design targets) and needs for improvements.
Results and discussions	5%	Description of the optimization results and comparisons to state-of-art designs in terms of material consumption, structural performance (e.g., stiffness, and strength), and manufacturability. The generalization or applicability of your optimization results. Any needs for future development (either in the software or optimization setting).
Fabrication (Path 1&2)	2%	Description of your fabrication process (e.g., types of printer, printer settings) and presentation of final fabricated specimen.
Algorithm description (Path 3)	2%	Further description of the setting of objective function, variables, constraints, how convexity is verified, and how the problem is solved.
Report quality	1.5%	Quality of presentation and logic flow. Proper citation of software and relevant studies. Please reference at least one journal paper on a similar topic and learn from their practice (e.g., how the loading was simplified). Papers from MDPI journal should be avoided. The report should be a maximum of 4 pages long (can definitely be shorter; we grade based on the quality instead of length). Letter/A4 size, Times New Roman, 12 pt, single line spacing, 1 in margin.
Presentation quality	1.5%	Quality of presentation and logic flow. Especially, reasonable use of figures for facilitating understanding.
Innovation and Practical significance	3% (Bonus)	Projects of high innovation and practical significance may receive up to 3% bonus points. Innovation may refer to various aspects, such as new topic, new simplification method, new methodology, new results and discussions. Please highlight your innovation with relevance to state-of-the-art practice and literature.

Presentation Guidelines

PechaKucha (*Pe-**chaa'**-koo-cha*) is a presentation technique using PowerPoint (or Keynote) for stand-up presentations. The typical PechaKucha presentation has 20 slides and each slide shows for exactly 20 seconds. The presenter has no control over slide advancement – it happens exactly every 20 seconds. Youcan learn more about the PechaKucha 20×20 format at pechakucha.org.

PechaKucha
12 X 20

For your Project presentation, we will be using a modified version called **PechaKucha 14×30**.Your presentations will have a total of 14 slides, and each will show for 30 seconds – so the entire presentation is 420 seconds or **7 minutes**. This will be followed by 1-2 minutes of questions from the audience.

Presentation Requirements

- For individual presentation, your presentation must have **exactly 14 slides** – no more and no less. If you choose paths 2 or 3 and form a team, you may use up to 14+7×(# students) slides. For team project, the presentation should be jointly delivered by the whole team.
- Your presentation software must be set to **automatically advance each slide every 30 seconds**. After the last slide your presentation will end. In PowerPoint, slide timing is set under the Transitions tab. In Keynote, slide timing is set in the Inspector. These settings must be selected in your presentation before you upload the final version.
- You may include timed builds, video, and other actions, but **each slide may only be on the screen for 30 seconds**. (If you want to hold longer on any slide, simply repeat it and it will be on the screen for 60 seconds.)

PechaKucha 14×30 Tips

- **Budget your Slides** – Plan the number of slides for each presentation area. Here is an *example* slidebudget for the path 1 project. Your budget may be different as long as you cover all the aspects.

1 – Introduction of the problem	2 – Background	3 – Background
4 – Background	5 – Problem setting	6 – Problem setting
7 – Optimization	8 – Optimization	9 – Optimization
10 – Optimization	11 – Results and discussions	12 – Results and discussions
13 – Fabrication	14 – Fabrication	

  - **Keep your slides visual with minimal text.** Try to limit the number of words **on a slide**. Avoid long sentences and paragraphs. Provide succinct phrases with key information for enhancing understanding.
  - **Try to use figures to illustrate ideas and enhance understanding.** The figures should provide useful information (not just cartoons or symbols).

- **Count your spoken words** – You speak at 2 words/second, so as each slide projects you can likely speak 60 words (remember no more than 10-20 words actually printed on your slide). Write out your talk and count the words you will say per slide. The Word-O-Later can help.

- **Practice!** – Timing is everything and you get better with practice. Make sure you have practiced this ***at least twice*** before you deliver it in class.