Syllabus

Special Topics in Computational Design and Fabrication
CSCI 1953B Spring 2026

Introductory Information

This course explores the core mathematical, algorithmic, and computational principles that drive modern design tools, focusing on digital design representations, generative design, optimization, and interactive exploration. Students will learn to develop computational models for automating design processes, implement algorithms for shape generation and performance evaluation, and integrate digital design with fabrication techniques such as 3D printing, laser cutting, and machine knitting. The course includes hands-on assignments and a final project where students build their own computational design workflow.

Learning Goals

By the end of the course, students will be able to:

- Develop computational models to automate design processes.
- Implement algorithms for shape generation and optimization.
- Bridge digital design with physical fabrication workflows.
- Apply algorithms to evaluate design performance.
- Create domain-specific abstractions for interactive design exploration.

Instructor: Adriana Schulz, She/Her
TAs: Vivian Li, She/Her
TAs: Oras Phongpanangam, He/Him
Office hours: TBD

Prerequisites

- A good working knowledge of Python programming
- Basic linear algebra (matrices and vectors)
- Some mathematical sophistication
- No prior knowledge of manufacturing is assumed

Communication

- See website for updates on lecture topics, calendar and lecture slides: `https://www.computationaldesign.group/courses/csci1953b-spring2026`
- Assignments will be posted and submitted via Canvas
- We will use Ed for a discussion board and direct messaging with instructors

Course Materials

- A laptop on which students can run Python code (either locally or through Google Colab) is required for completing homework assignments.
- Students should also be able to install software used in lab sessions, such as OpenSCAD and other free or open-source tools provided during the course.
- Students are responsible for obtaining any additional resources required for their chosen final project, which may involve higher computational power, specific software, or fabrication materials beyond those used in labs. For example, if a student selects a project that involves a specific fabrication technique for which resources are not available through the course, they may need to acquire materials on their own. It is up to students to choose their projects based on the resources they have access to.

1 General Policies

This syllabus is designed to be a guideline for the course and these policies are subject to change.

Grades

- 50% Assignments
- 35% Course Project
- 15% Participation
- No final exam

2 Assignment Policies

- There will be **five programming assignments**, completed individually, following the same format throughout the semester. Assignments are worth 50% of final grade and each individual assignment will be worth (10/50) points.
- Initial code and libraries will be provided for all assignments.

- **Collaboration policy** Discussions are encouraged but implementations and write-ups must be done *individually*. Students are encouraged to meet up and discuss assignments. They can write ideas or pseudo-code on paper or a whiteboard during discussions but they may *not* take any code or notes away from those conversations. A good rule of thumb is the Gilligan's Island Rule[1]. Please indicate in your writeup any discussion group you participated in.

- **Late policy** Assignments must be submitted by 7:59pm on the listed due date. Late days are measured in periods of 24 hours. You have 5 late days with no penalty for the whole semester but can use no more than 3 for any given assignment. Beyond this, late assignments will lose 25% credit per day (additive). Days are measured in periods of 24 hours (no special considerations about weekends outside of the fact that the TA may not respond to Ed questions during that period). Please read the details carefully under **"Don't suffer in silence"** below.

3 Course Project Policies

The course project accounts for **35%** of the total course grade and is completed in **groups of three students**. Each group will design and implement a **domain-specific computational design tool** for a fabrication domain of their choice.

Projects should be narrowly scoped and deeply tailored to a particular fabrication process, material, or application area. The more domain-specific the tool, the better. Students are encouraged to choose a domain they are excited about or passionate about, and to design tools that are fun, creative, and engaging to use.

We will help students form project groups as needed to ensure groups of three. If the class size does not allow for groups of exactly three, there will be **one** group of two *or* **one** group of four students, and grading will be adjusted accordingly for that single group.

Project Deliverables and Evaluation

The project consists of three deliverables distributed across the semester. Across all deliverables, grading will be based on a **combination of self-assessment and peer assessment**. This structure is intended to help students reflect on their own work, learn from others' systems, and engage critically with different design approaches.

Deliverable 1: Domain-Specific Design Interface (10/35). The goal of the first deliverable is to design a user interface that allows others to meaningfully create designs in the chosen fabrication domain. During an in-class session, at least **three other students** must use the interface to create **three different designs**. After using the tool, students

[1]The Gilligan's Island Rule: This rule says that you are free to meet with fellow student(s) and discuss assignments with them. Writing on a board or shared piece of paper is acceptable during the meeting; however, you should not take any written (electronic or otherwise) record away from the meeting. After the meeting, engage in a half hour of mind-numbing activity (like watching an episode of Gilligan's Island), before starting to work on the assignment. This will assure that you are able to reconstruct what you learned from the meeting, by yourself, using your own brain.

will provide peer feedback evaluating the usability of the interface and how well it supports domain-specific design. Each group will also reflect on how their interface enables or constrains design decisions within their chosen domain.

Deliverable 2: Fabrication Demonstration (10/35). Groups will fabricate **three physical artifacts** produced using their design system. Whenever possible, these should be the designs created during Deliverable 1; if this is not feasible, groups may fabricate alternative designs that are representative of the design space. Groups will present the fabricated artifacts in class and discuss the fabrication process, challenges encountered, and how the experience informed iterations to their design tool or specifications. Evaluation will combine self-assessment and peer feedback.

Deliverable 3: Automatic Design Generation (15/35. Groups will extend their system to automatically generate designs from a high-level specification, such as a text prompt

4 Participation Policies

- Engaging in class discussion is essential for one of the key learning objectives of this course: to reflect on computational solutions that will enable the next-generation design tools for manufacturing that fundamentally change what can be made, and by whom. **Since there are no scheduled exams and the coding assignments can only reflect a small portion of the topics discussed in class, the participation grade is designed to reflect this key learning objective.**

- **Each lecture is worth 0 or 1 participation point, and the lowest 6 scores will be dropped.** This allows students to miss up to 6 lectures without penalty. In cases of extenuating circumstances, students may recover a participation point for a missed lecture by submitting a report on that lecture. See details under **"Don't Suffer in Silence"** below.

- Students will be awarded one participation point for every lecture they are *actively* present, participation is measured using "Duck Points".

  Participating Ducks, or "Duck Points" Each student will receive one rubber duck at the beginning of the semester, which they should keep and return by the end of the semester. During each class, the student can throw the duck to the lecturer when they engage in class discussion — engagement means either asking or answering a question. The lecturer will keep the "participating ducks" at the front of the classroom until the end of class. At the end of the class, the TAs will take note of all the ducks that are up front and give their owner students a participation point for that lecture. **Note:** Adriana is known to have no chance at a career as a catcher. You will get your participation point whether or not she is able to catch your duck at the first throw, but she will be very excited if she is able to do it so you should try to make it easy on her ;)

- There is no extra credit for participation. You can keep track of your grade on CANVAS. Please check CANVAS from time to time and let the TA know if there is a mistake, as these can happen with ducks flying around :).

5 Academic Honesty

Please review the Brown University Academic Code: `http://www.brown.edu/academics/college/degree/policies/academic-code`. All work submitted for grading should reflect your own individual effort. Discussions with other students or the instructors are allowed, but copying is not acceptable. Sharing, copying, or obtaining information from unauthorized sources during any assessment activities in this class are violations of the code. Misunderstanding of the Academic Code is not accepted as an excuse for dishonest work.

5.1 Use of AI Tools Policy

Students are **encouraged** to utilize AI tools such as ChatGPT and Copilot to support their learning and homework completion. However, any work submitted must be original and must not be represented as the sole product of the student. When employing AI tools, students are required to include a detailed discussion that addresses the following points:

1. **Utilization of AI Tools:**
   - Detail how and where the tool was implemented. Elaborate on why the tool was chosen and whether it helped in achieving the set goals.
   - *Example:* What prompts were utilized to obtain the final result? Were there instances when the tool failed? Was there a need to iterate on prompts? Did the tool reduce development time or aid in resolving impediments? Was it instrumental in overcoming a block?
2. **Interpretation of Results:**
   - Explain the methods used to verify the correctness of the obtained result.
   - *Example:* Could you interpret what the generated code was intended to do and perform a sanity check to ensure it accomplished the goal? Or did you run the code and validate that it worked on the examples provided?
3. **Impact on Learning Experience:**
   - Reflect on how utilizing AI tools affected your grasp of the subject matter.
   - *Example:* Did it allow you to concentrate on core class concepts, such as geometric and mathematical ideas, with the AI handling computational details, or did it hinder learning by solving problems and eliminating the need to engage with key geometric insights?

6 Supporting Students: "Don't suffer in silence!"

We recognize that our students come from varied backgrounds and can have widely-varying circumstances. Our ultimate goal is to help every student be successful in the course. Extenuating circumstances can include physical or mental health and wellness, work-school-life balance, familial responsibilities, military duties, unexpected and unavoidable travel, or anything else beyond your control that may negatively impact your performance in the class. While we want to make sure all students feel comfortable reaching out to the staff under extenuating circumstances, we have two important concerns:

1. People come from diverse backgrounds and therefore may be more or less likely to feel comfortable asking for special accommodations. Policies that set up harsh deadlines but then are flexible to all students who reach out to ask for special accommodation lead to students not being treated equally and can impact students from diverse backgrounds negatively. To this end, we have decided to make policies for handling extenuating circumstances explicit as part of the syllabus. We also designed this policy so that students do not have to disclose specifics of their circumstances to the staff, which may cause additional discomfort.

2. Students who are suffering from extenuating circumstances often require additional support. Brown has many resources in place to support such students and it is our duty as instructors to make sure that students who are struggling do in fact reach out to those resources so that they can get the support they need. Therefore we clearly outline what types of exemptions we are willing to make directly and which ones cannot be granted without the supervision of staff dedicated to supporting students.

We outline such policies below.

Accommodating late assignments beyond the late day policy As previously mentioned you get 5 "free" late days to use throughout the semester (no more than 3 per assignment). In case of unforeseen or extenuating circumstances when students need more time to finish the assignment beyond the free late days, students should email the staff mailing list, and say:

> "I am dealing with extenuating circumstances and need support for turning in my next assignment. I am already using Y of my "free" late days on this assignment, but I will need X days beyond that, so I am requesting to turn it in on the requested date = [due date + X + Y]. "

This request will be granted if the staff is able to accommodate the extra burden of grading (date $\leq$ March 13) and if one of the following is true:

- $X \leq 3$ and this is the first or second time in the semester the student has reached out requesting extra time for an assignment. (This should support students who are struggling with a one-off unenforceable circumstance but do not require additional support).

- We receive an email from SAS or SSS requesting special accommodations (This should support students who need special accommodations.)
- An academic advisor (or equivalent from another department) is cc'ed in the email and follows up to say "I have been in touch with the student and I am working with them to support them in this extenuating circumstance. I think it is appropriate for the Staff of CSCI 2952Y to grant this exception if it is possible." (This should support students are dealing with extenuating circumstances but have reached out to the Brown resources and are getting the appropriate support). I you need help getting in touch with advising, we would be happy to assist.
- A research advisor (or another faculty mentor within Brown) is cc'ed in the email and follows us to say "I am aware of this request and think it is appropriate for the Staff of CSCI 2952Y to grant this exception if it is possible." (This should support students who need special accommodations but are getting the appropriate support from another faculty mentor.)

Policy for accommodating missed lectures: If you have to miss lectures and want to make up for participation grade, you can submit a report on the lecture that you missed. Please note that we cannot guarantee that recordings will be available and you may need to reach out to colleagues or the TA for help understanding the lecture you missed. In case of unforeseen or extenuating circumstances, student should email the staff mailing list, and say: "Because of personal circumstances, I had to miss class X and I would like to submit this report (attached) to show that I understand the material that was covered." Please *include* the TAs and do *not* disclose the specific circumstances in your email. All reports must include all topics discussed in the class, and must be submitted by March 13. We will accept up to 5 reports. If you need to submit more that 5 reports (that means you will miss more that half of the semester), we recommend you contact advisors, SSS or SAS.

Note on Accommodations for Individual Projects The course project is intentionally designed to be completed in groups of three. A core learning objective of this course is to help students develop experience working collaboratively on open-ended computational design problems, including communication, coordination, and shared decision-making. In addition, the structure of the project deliverables—particularly the in-class sessions where students interact with and evaluate other groups' design tools—relies on having a manageable number of projects in the course.

For these reasons, we generally do **not** accommodate individual projects. Allowing individual projects would significantly increase the number of projects in the course and make the in-class evaluation and peer interaction components infeasible.

That said, we recognize that students may face extenuating circumstances. Consistent with the principles outlined in **"Don't Suffer in Silence"**, exceptions may be considered only in cases where we receive a formal accommodation request through the appropriate university channels (e.g., Student Accessibility Services or a request communicated by a

Dean, academic advisor, or equivalent university office). In such cases, we will work with the student and the relevant office to determine an appropriate accommodation.

Accessibility and Accommodations

Your experience in this class is important to us. If you have already established accommodations with student accessibility services (SAS), please communicate your approved accommodations to the instructor at your earliest convenience so we can discuss your needs in this course. If you have not yet established services through SAS, but have a temporary health condition or permanent disability that requires accommodations (conditions include but are not limited to: mental health, attention-related, learning, vision, hearing, physical or health impacts), contact SAS directly to set up an Access Plan. SAS facilitates the interactive process that establishes reasonable accommodations.

Lecture Recordings

This course is scheduled to be fully in-person, but lectures will be recorded. Because technical issues with recordings may arise, we cannot guarantee that all lectures will be made available offline and therefore students are strongly encouraged to attend classes unless they are unable due to extraordinary circumstances.

Privacy Note: The recording will capture the presenter's audio, video, and computer screen. Students' voices during lecture will be captured in the recordings.