



ARCH 694 L2 | Tectonic Agendas, 3D Printing

H (1.5)

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Office Hours: By appointment

Mondays & Wednesdays, 11:00 am – 12:15 am

Sessions are in person in PF 2110

Introduction

Among all manufacturing techniques, additive manufacturing (AM), also known as 3D printing, has been developed to aid engineers and designers in the product-process design phase in evaluating specific material-related properties. Compared to conventional manufacturing methods (such as milling, modelling, and stamping), AM technologies provide unprecedented freedom in producing highly complex geometries. This course will highlight how 3d printing applies to architecture in education and practice. The students will learn to generate structurally stable forms based on loads, constraints, and fabrication methods. In this class, we will:

- Explore different Additive Manufacturing (AM) technologies and their underlining principles
- Build the ability to evaluate 3D printing techniques and materials for fast prototyping
- Improve
- the ability to design complex geometries and generate costume/standard gcode for 3D print
- Study the gcode structure and commands
- Explore future applications and opportunities of 3D printing
- Explore the implications of AM technology in architecture
- Evaluate the current state of the 3D printing industry and its global impacts on the future of the building construction
- Develop and foster teamwork
- Develop and learn critical thinking

Objectives

After taking this course, students will be able to:

- Identify 3d printing applications
- Make a persuasive argument for the use of 3D printing and rapid prototyping to foster creativity and learning in architecture
- Utilize 3d modelling software (Rhino/grasshopper) to design and create printable digital 3d models
- Understand the structure of the gcode
- Set up, operate, control, tune, and troubleshoot a 3d printer and relevant slicing software

Teaching Approach

The course will have both the lectures and the workshop format. During the course, students will work on 2 projects and one final project focusing on critical thinking and the development process of designing an architectural spatial structure and fabricating the prototype. Students will use Rhino/grasshopper and relevant plugins or other CAD softwares to design the digital models and generate the GCode. Then prototypes will be 3D printed using appropriate AM methods and materials. Students will present their final 3D printed projects in the last week of the class.

Course Schedule

Topic Areas, Assignments and Due Dates

Week 1

January 9
11

Lecture: Introduction to the course and
Lecture: Introduction to Additive Manufacturing (AM) technologies Starting project one

Week 2

January 16
18

Lecture: 3D printable materials and their properties
Workshop: 3D modelling and code generation for 3D printing (Rhino)

Week 3

January 23
25

Project one submission & Starting Project two
Lecture: Clay 3D Printing

Week 4

January 30
February 1

Project Consultation
Project two submission & Starting Project three

Week 5

February 6
8

Digital model troubleshooting
Project Consultation

Week 6

February 13
15

Digital model troubleshooting
Project Consultation

Week 7

February 20
22

Alberta Family Day Holiday
(Term Break)

Week 8

February 27

Project three submission & Final Presentation

Means of Evaluation

The course evaluation will be based on the assignments completed during the course, including the final project presentation. In the case of group assignments, participants will be asked to describe their contribution to the assignment. There will be no final examination.

- Project 1 – AM Project Design and Fabrication (small scale) 15%
- Project 2 – Digital Design for 3D printing 20%

• Project 3 – Prototype Fabrication	40%
• Outcome	15%
• Participation in lecturers and Workshops	10%
• Total	100%

Note: A passing grade in all assignments is required to pass the course as a whole.

Policy for Late Assignments

Assignments submitted after the deadline will be penalized with the loss of a grade (e.g., A- to B+). For late submission after one week but not more than 2 weeks, the loss will be two grades, e.g., A- to B. Assignments will not be accepted after 3 weeks.

Guidelines for Zoom Sessions in Online Classes

This course will take place in person. However, online sessions are via Zoom meetings. Students are expected to participate actively in all Zoom sessions and to turn on their webcam. Please join our class in a quiet space that will allow you to be fully present and engaged in the Zoom sessions. Students must behave in a professional manner during the session. Students, employees, and academic staff are also expected to demonstrate behaviour in class that promotes and maintains a positive and productive learning environment. If unable to participate live due to unforeseen circumstances, inform the instructor in advance to work out an alternative participation activity (e.g., watch the recordings, submit a brief reflection, and actively contribute to the follow-up online discussion).

Zoom is a video conferencing program that will allow us to meet at specific times for a "live" video conference, so that we can have the opportunity to meet each other virtually and discuss relevant course topics as a learning community. To help ensure Zoom sessions are private, do not share the Zoom link or password with others, or on any social media platforms. Zoom links and passwords are only intended for students registered in the course. Zoom recordings and materials presented in Zoom, including any teaching materials, must not be shared, distributed or published without the instructor's permission.

The use of video conferencing programs relies on participants to act ethically, honestly and with integrity; and in accordance with the principles of fairness, good faith, and respect (as per the [Code of Conduct](#)). When entering Zoom or other video conferencing sessions (such as MS Teams), you play a role in helping create an effective, safe and respectful learning environment. Please be mindful of how your behaviour in these sessions may affect others. Participants are required to use names officially associated with their UCID (legal or preferred names listed in the Student Centre) when engaging in these activities. Instructors/moderators can remove those whose names do not appear on class rosters. Non-compliance may be investigated under relevant University of Calgary conduct policies (e.g. [Student Non-Academic Misconduct Policy](#)). If participants have difficulties complying with this requirement, they should email the instructor of the class explaining why, so the instructor may consider whether to grant an exception, and on what terms. For more information on how to get the most out of your zoom sessions visit: <https://elearn.ucalgary.ca/guidelines-for-zoom/> If you are unable to attend a Zoom session, please contact your instructor in advance to arrange an alternative activity for the missed session (e.g., to review the recorded session). Please be prepared, as best as you are able, to join class in a quiet space that will allow you to be fully present and engaged in Zoom sessions. Students will be advised by their instructor when they are expected to turn on their webcam (for group work, presentations, etc.).

The instructor may record online Zoom class sessions for the purposes of supporting student learning in this class – such as making the recording available for review of the session or for students who miss a session. Students will be advised before the instructor initiates a recording of a Zoom session. These recordings will be used to support student learning only and will not be shared or used for any other purpose.

Technology requirements (D2L etc.):

All the course materials will be available on the D2L. In order to successfully engage in their learning experiences at the University of Calgary, students are required to have reliable access to the following technology:

- A computer with a supported operating system, as well as the latest security and malware updates;
- A current and updated web browser;
- Webcam (built-in or external);
- Microphone and speaker (built-in or external), or headset with microphone;
- Current antivirus and/or firewall software enabled;
- Broadband Internet connection.

Software Requirements

Rhinocores, Grasshopper and Plugins are relevant to the projects.

Required readings, textbooks and learning materials:

Required (and recommended) textbooks, readings, and materials, including electronic resources, will be announced during the class.

Workshop Safety Training Requirement

If a course requires the use of the SAPL workshop, students must complete all online University of Calgary safety courses, the online Trajectory safety training course, as well as in-person workshop training and a grade of pass on the final evaluation project, to be granted access to the SAPL workshop. This training is offered once a year, around the start of the Fall term and has a completion deadline.

Grading Scale				
Grade	Grade Point Value	4-Point Range	Percent	Description
A+	4.00	4.00	95-100	Outstanding - evaluated by the instructor
A	4.00	3.85-4.00	90-94.99	Excellent - superior performance showing a comprehensive understanding of the subject matter
A-	3.70	3.50-3.84	85-89.99	Very good performance
B+	3.30	3.15-3.49	80-84.99	Good performance
B	3.00	2.85-3.14	75-79.99	Satisfactory performance
B-	2.70	2.50-2.84	70-74.99	Minimum pass for students in the Faculty of Graduate Studies
C+	2.30	2.15-2.49	65-69.99	All final grades below B- are indicative of failure at the graduate level and cannot be counted toward Faculty of Graduate Studies course requirements.
C	2.00	1.85-2.14	60-64.99	
C-	1.70	1.50-1.84	55-59.99	
D+	1.30	1.15-1.49	50-54.99	
D	1.00	0.50-1.14	45-49.99	
F	0.00	0-0.49	0-44.99	

Notes: A student who receives a "C +" or lower in any one course will be required to withdraw regardless of their grade point average (GPA) unless the program recommends otherwise. If the program permits the student to retake a failed course, the second grade will replace the initial grade in the calculation of the GPA, and both grades will appear on the transcript.

University of Calgary Policies and Supports

COVID-19 PROCEDURE FOR SICK STUDENTS: <https://ucalgary.ca/risk/sites/default/files/Covid-19%20Folder/COVID-19-Procedure-for-Sick-Students.pdf>

ACADEMIC ACCOMMODATION

It is the student's responsibility to request academic accommodations according to the University policies and procedures listed below. The Student Accommodations policy is available at <https://ucalgary.ca/student-services/access/prospective-students/academic-accommodations>. Students needing an accommodation based on disability or medical concerns should contact Student Accessibility Services (SAS) in accordance with the Procedure for Accommodations for Students with Disabilities (<https://www.ucalgary.ca/policies/files/policies/procedure-for-accommodations-for-students-with-disabilities.pdf>). Students who require an accommodation in relation to their coursework based on a protected ground other than Disability should communicate this need in writing to their instructor.

SAS will process the request and issue letters of accommodation to instructors. For additional information on support services and accommodations for students with disabilities, visit www.ucalgary.ca/access/.

ACADEMIC MISCONDUCT

Academic Misconduct refers to student behavior which compromises proper assessment of a student's academic activities and includes: cheating; fabrication; falsification; plagiarism; unauthorized assistance; failure to comply with an instructor's expectations regarding conduct required of students completing academic assessments in their courses; and failure to comply with exam regulations applied by the Registrar.

For information on the Student Academic Misconduct Policy and Procedure please visit:

<https://ucalgary.ca/policies/files/policies/student-academic-misconduct-policy.pdf>

<https://ucalgary.ca/policies/files/policies/student-academic-misconduct-procedure.pdf>

Additional information is available on the Academic Integrity Website at <https://ucalgary.ca/student-services/student-success/learning/academic-integrity>.

COPYRIGHT LEGISLATION:

All students are required to read the University of Calgary policy on Acceptable Use of Material Protected by Copyright (www.ucalgary.ca/policies/files/policies/acceptable-use-of-material-protected-by-copyright.pdf) and requirements of the copyright act (<https://laws-lois.justice.gc.ca/eng/acts/C-42/index.html>) to ensure they are aware of the consequences of unauthorised sharing of course materials (including instructor notes, electronic versions of textbooks etc.). Students who use material protected by copyright in violation of this policy may be disciplined under the Non-Academic Misconduct Policy (<https://www.ucalgary.ca/pubs/calendar/current/k.html>).

INSTRUCTOR INTELLECTUAL PROPERTY

Course materials created by instructors (including presentations and posted notes, labs, case studies, assignments and exams) remain the intellectual property of the instructor. These materials may NOT be reproduced, redistributed or copied without the explicit consent of the instructor. The posting of course materials to third party websites such as note-sharing sites without permission is prohibited. Sharing of extracts of these course materials with other students enrolled in the course at the same time may be allowed under fair dealing.

FREEDOM OF INFORMATION AND PROTECTION OF PRIVACY

Student information will be collected in accordance with typical (or usual) classroom practice. Students' assignments will be accessible only by the authorized course faculty. Private information related to the individual student is treated with the utmost regard by the faculty at the University of Calgary.

SEXUAL VIOLENCE POLICY

The University recognizes that all members of the University Community should be able to learn, work, teach and live in an environment where they are free from harassment, discrimination, and violence. The University of Calgary's sexual violence policy guides us in how we respond to incidents of sexual violence, including supports available to those who have experienced or witnessed sexual violence, or those who are alleged to have committed sexual violence. It provides clear response procedures and timelines, defines complex concepts, and addresses incidents that occur off-campus in certain circumstances. Please see the policy available at

<https://www.ucalgary.ca/policies/files/policies/sexual-violence-policy.pdf>

UNIVERSITY STUDENT APPEALS OFFICE: If a student has a concern about the course, academic matter, or a grade that they have been assigned, they must first communicate this concern with the instructor. If the concern cannot be resolved with the instructor, the student can proceed with an academic appeal, which normally begins with the Faculty.

<https://www.ucalgary.ca/secretariat/student-appeals>

OTHER IMPORTANT INFORMATION

Please visit the Registrar's website at: <https://www.ucalgary.ca/registrar/registration/course-outlines> for additional important information on the following:

- Wellness and Mental Health Resources
- Student Success
- Student Ombuds Office
- Student Union (SU) Information
- Graduate Students' Association (GSA) Information
- Emergency Evacuation/Assembly Points
- Safewalk