TU Delft Delft University of Technology

Faculty of Architecture & the Built Environment

3D modelling of the built environment (GEO1004) — 5 ECTS

Location: CEG-Instruction Room 2.99
Date & time: 14 July 2025, 9:00
Responsible teacher: Ken Arroyo Ohori

1. The subject matter is in full accordance with the study guide.
2. This final exam is worth 50% of the final mark for the course.
3. The maximum grade for this course is 10.0. The minimum (unrounded) final mark to pass this course is 5.75, which will be rounded to 6.0. However, you need at least 50% in this resit exam to be able to pass the course.
4. All questions have equal weight in this exam.
5. Answer directly on these pages. If there is not enough space, use the extra sheet at the end.
6. This is an open book/computer exam, so you are free to check the course materials (videos/handouts/assignments), both printed or on your computer, as well as any other materials you can find. However, you are **not allowed to communicate with others** and **the use of your phone is forbidden**.
7. This resit exam has 12 questions, and 14 pages.
8. Fill out your name and student ID.
9. You have 2 hours to do this exam.

Name: _____

Student ID: _____

Lesson 1.2

Write three statements about your own implementation of Homework 2 in terms of its handling of geometry, topology and semantics. There should be one clear statement about each of the three components (⅓ point each).

Lesson 2.1

In the context of 3D modelling, what is the relationship between boundary representation and meshes? Explain it in your own words (½ point) and provide an example based on your implementation of Homework 1 (½ point).

Lesson 2.2

Say you have one OBJ of a valid building. **(a)** What are the differences between creating a constrained tetrahedralisation and creating a constrained triangulation of its surfaces? (½ point). **(b)** If you wanted to calculate the volume of the building, would both methods allow you to do it? If yes, explain how. If not, explain why not (½ point).

Lesson 3.2

Using hierarchical structures to store voxels (e.g. octrees) can be more or less efficient than the usual (dense) encoding of voxels. Using the typical features of a 3D city model (e.g. buildings, roads, water bodies and vegetation), describe an example where they would be more efficient and one where they would be less efficient (½ point each).

Lesson 4.1

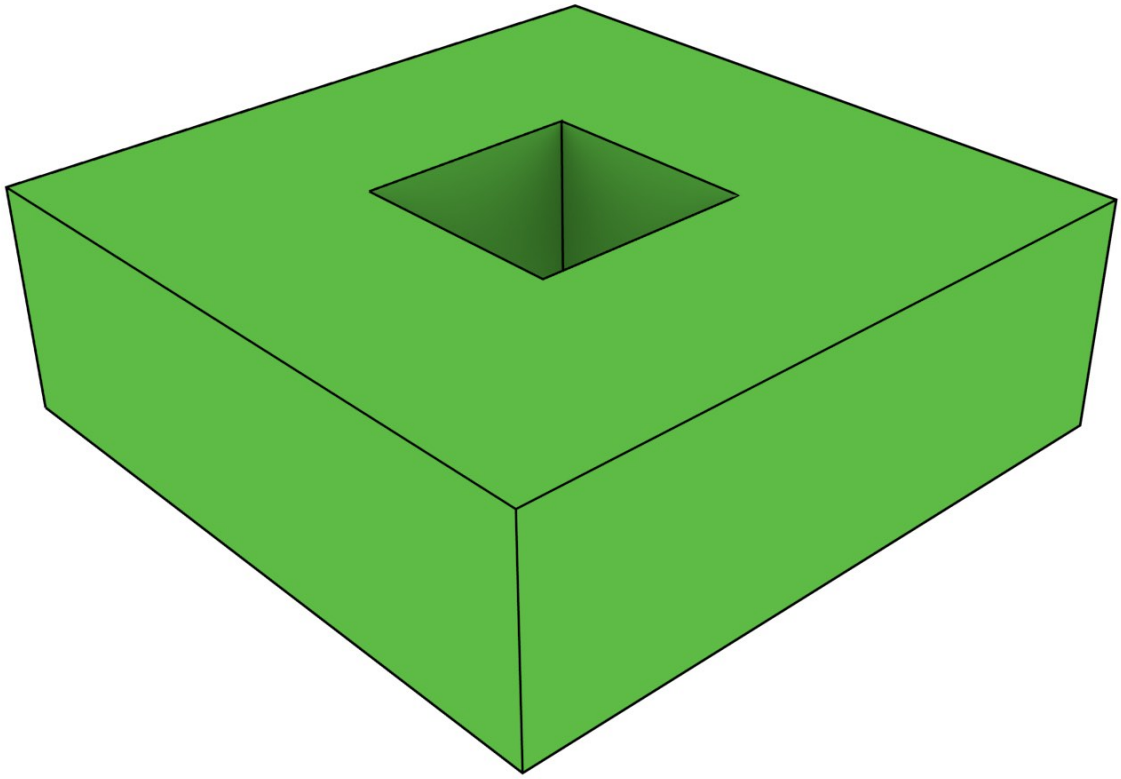
(a) Draw two Solids with a hole that have the same topology: one should be valid according to ISO19107 and the other one should not be (½ point). **(b)** Explain briefly why the first is valid and why the second is not (½ point).

Lesson 4.2

During Homeworks 2 and 3, you read, modified, and wrote to disk several CityJSON files. Describe in detail two drawbacks of this format (¼ point each), which can be related to low-level issues, to the libraries used, etc. For each drawback, give a concrete example of how that negatively affected you during an assignment (¼ point each).

Lesson 5.1

Draw and describe the MAT of the shape depicted below.



Lesson 5.2

Plot a quadratic Bézier curve with point coordinates $(0,0)$, $(1,0)$, $(1,1)$ (½ point). Use it to illustrate what happens at different values of t (½ point).

Lesson 6.1

Explain why it is often difficult to preserve semantics when processing geometries using CSG. Feel free to use your own experience when implementing Homework 3.

Lesson 6.2

The methodology that was proposed to solve Homework 3 involved using 'IfcConvert' to generate OBJ files. Based on what you've learned in this course, justify whether this a good or bad solution (or explain pros and cons) compared to directly parsing the IFC files.

Lesson 7.1

You want to apply the reconstruction method from the 3D book, but the building footprints do not form a planar partition. Explain in detail how would this affect the method and the results obtained with it.

Lesson 7.2

When triangulating a polygon without holes, can you use the barycentric triangulation implied by gmaps instead of a constrained triangulation? **(a)** Yes/no (½ point). **(b)** Explain your reasoning (½ point).

[this page is left intentionally blank; it is meant as extra space for answers or draft]