# TUDelft
Delft
University of
Technology

Faculty of Architecture & the Built Environment

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

Location: Pulse-Hall 10
Date & time: 15 April 2024, 9:00
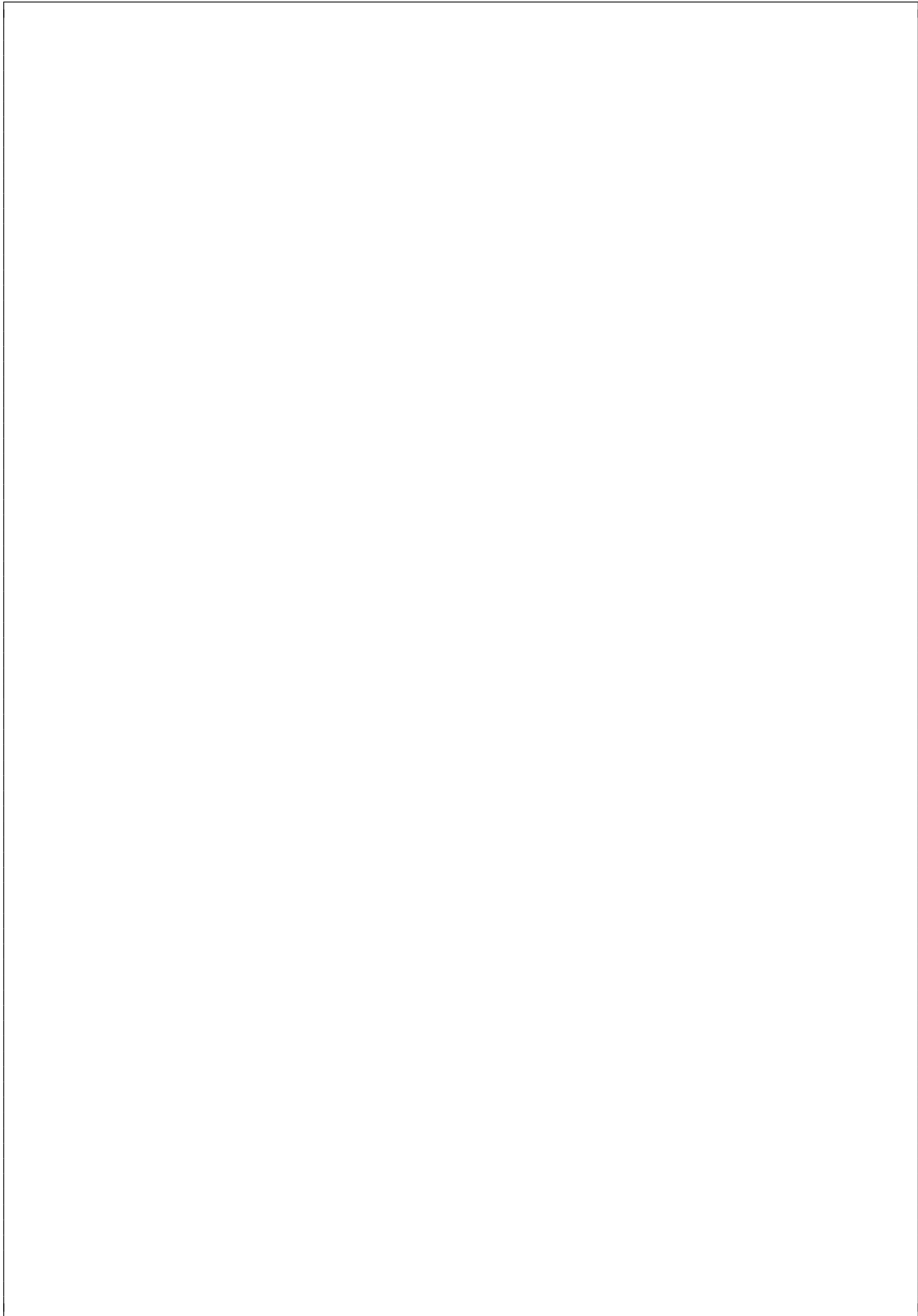Responsible teacher: Ken Arroyo Ohori

1. The subject matter is in full accordance with the study guide.

2. This final exam is worth 45% 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 a weighted average of at least 50% in the combined exams ($0.1\times$midterm $+ 0.9\times$final) 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 pages 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 exam has 12 questions, and 16 pages.

8. Fill out your name and student ID.

9. You have 1 hour to do this exam.
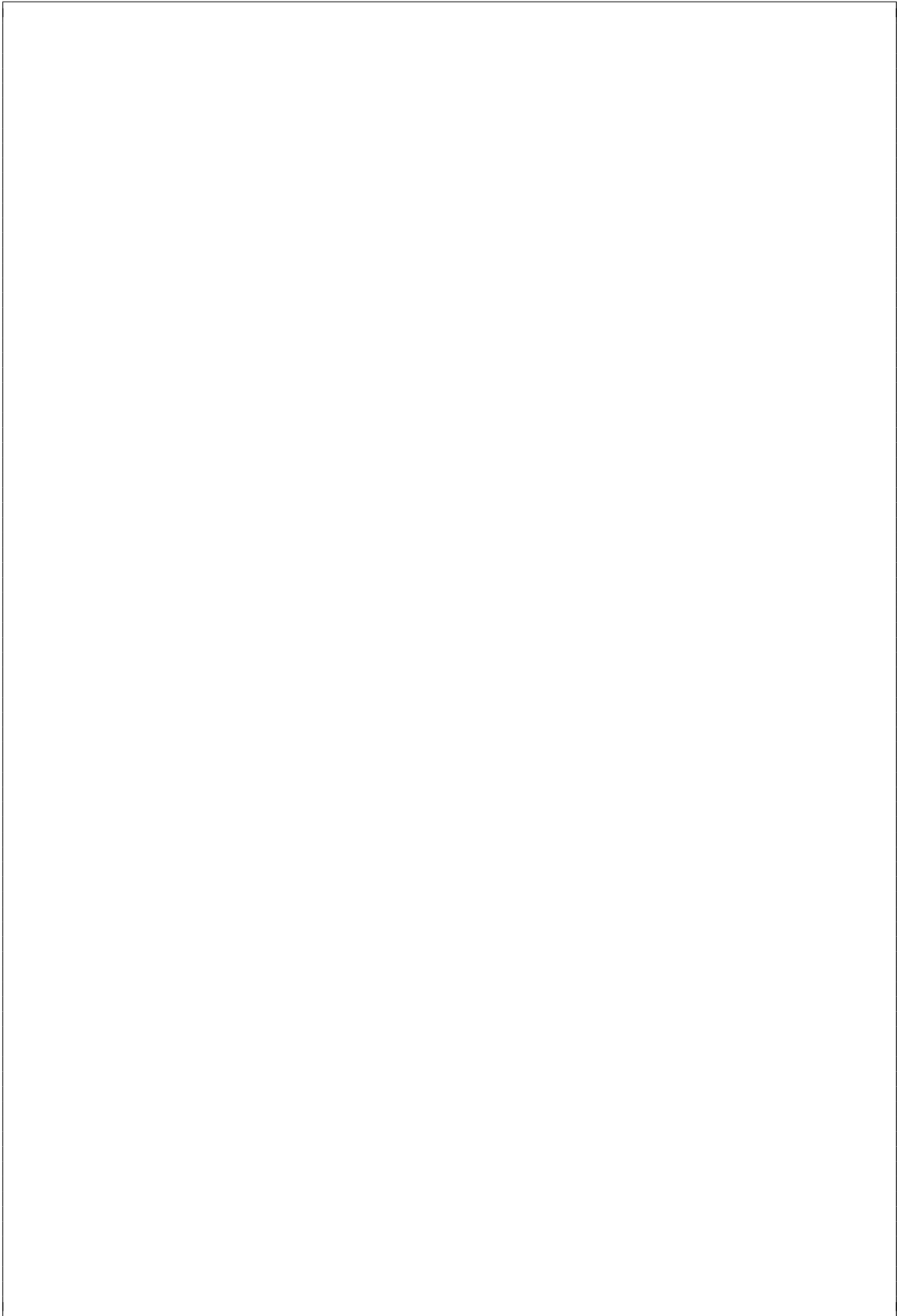
**Name:** _____

**Student ID:** _____

Lesson 1.1

Describe your own implementation of Homework 1 in terms of its handling of geometry, topology and semantics. There should be one statement about each of the three components.

Lesson 1.2

In the context of 3D modelling, when we talk about manifoldness we generally mean 2-manifoldness. Why is that?

Lesson 2.1

Say you have one CityJSON file of a geometrically-valid building (according to ISO19107). (1) Is it always possible to construct a constrained tetrahedralisation of it? Explain. (2) Give 2 use-cases where the constrained tetrahedralisation of a building could be useful in practice.
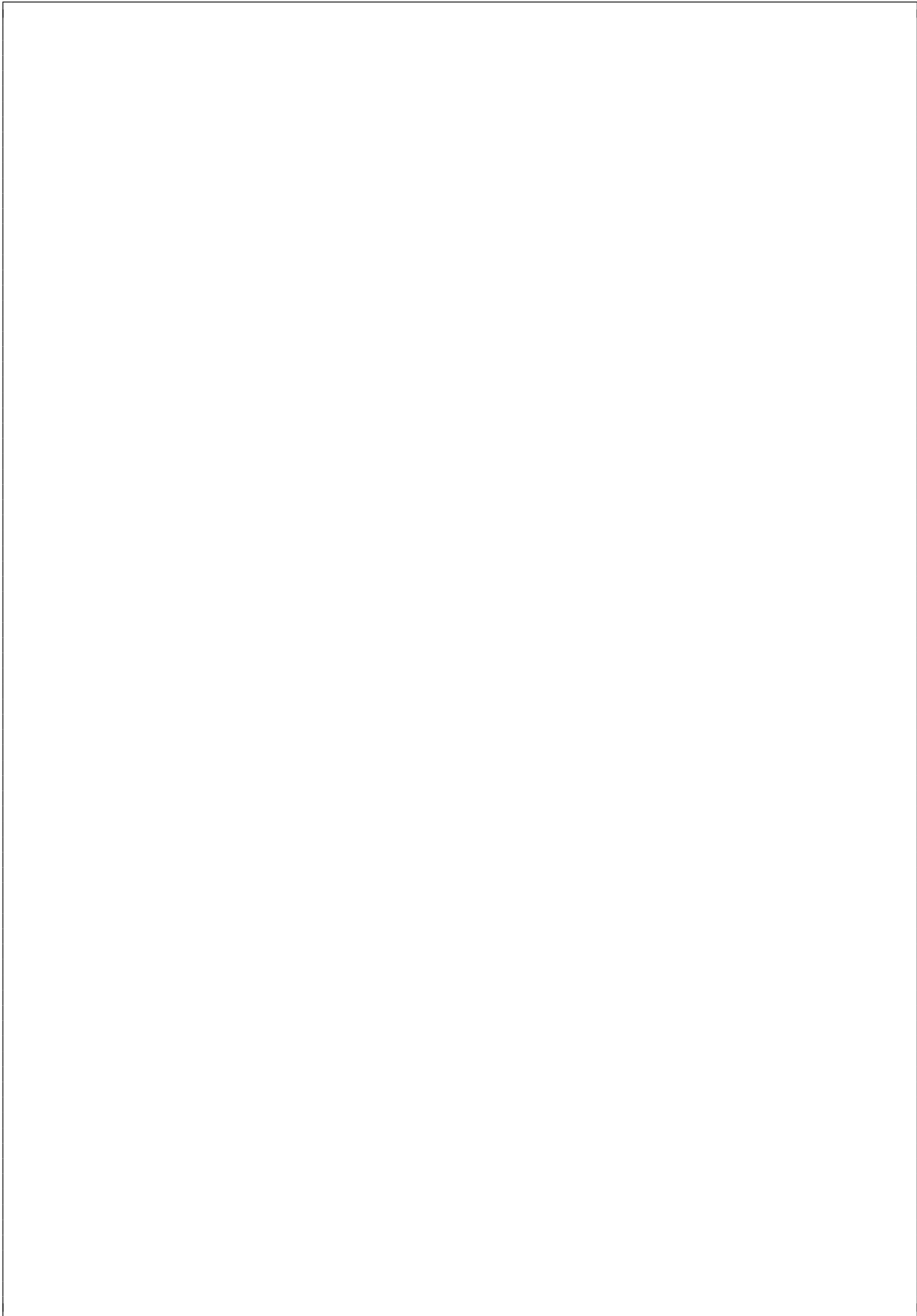
Lesson 2.2

When implementing Homework 3, one of your classmates is having issues because their exterior is leaking into the rooms, resulting in rooms that are labelled as exterior. You think this has to do with the connectivities used. Explain in detail the issue and the solution.
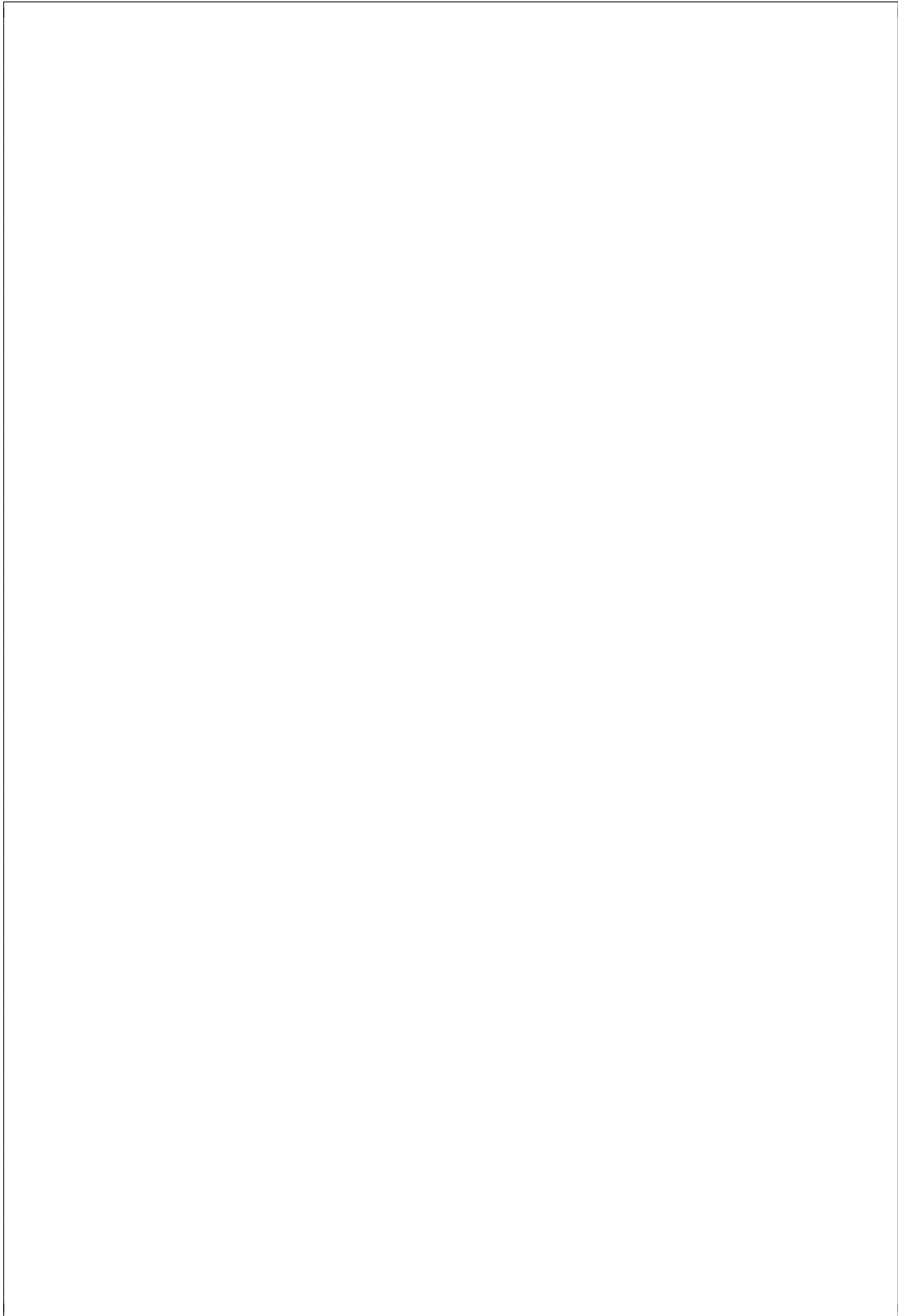
Lesson 3.1

(1) Draw a solid that has a genus of 2, the solid should be composed of surfaces having no inner boundaries. (2) Explain your drawing and report on the number of surfaces and vertices. (3) Also explain whether this solid is a 2-manifold or not.

Lesson 3.2

Starting from an AHN4 point cloud of Delft, how could you use the MAT to extract the points on the surface of the faculty building?

Lesson 4.1

You obtain a CityJSON file of the buildings of your city, and val3dity reports error 307--
`POLYGON_WRONG_ORIENTATION` for most of them. The person who constructed the file wasn't
aware of that rule. Based on what you learned in this course, describe in details the C++
code that you would write to repair automatically those buildings. You are allowed to use
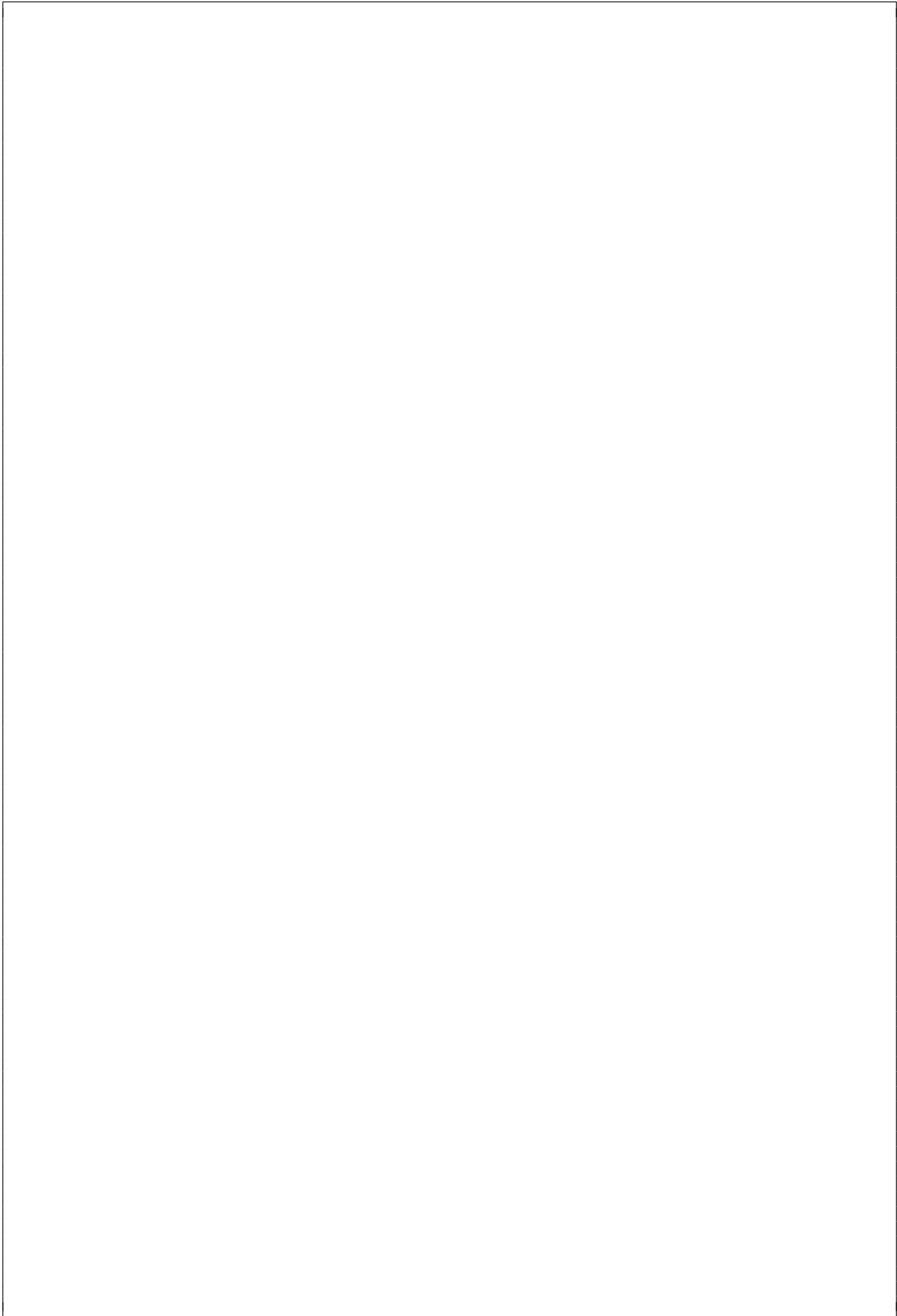the libraries that we used for the course.

Lesson 4.2

As explained in Section 12.3.2.3 of the book, an edge of the roof partition can generate 0, 1 or 2 wall faces. Explain concretely why this is the case using two neighbouring buildings as examples.
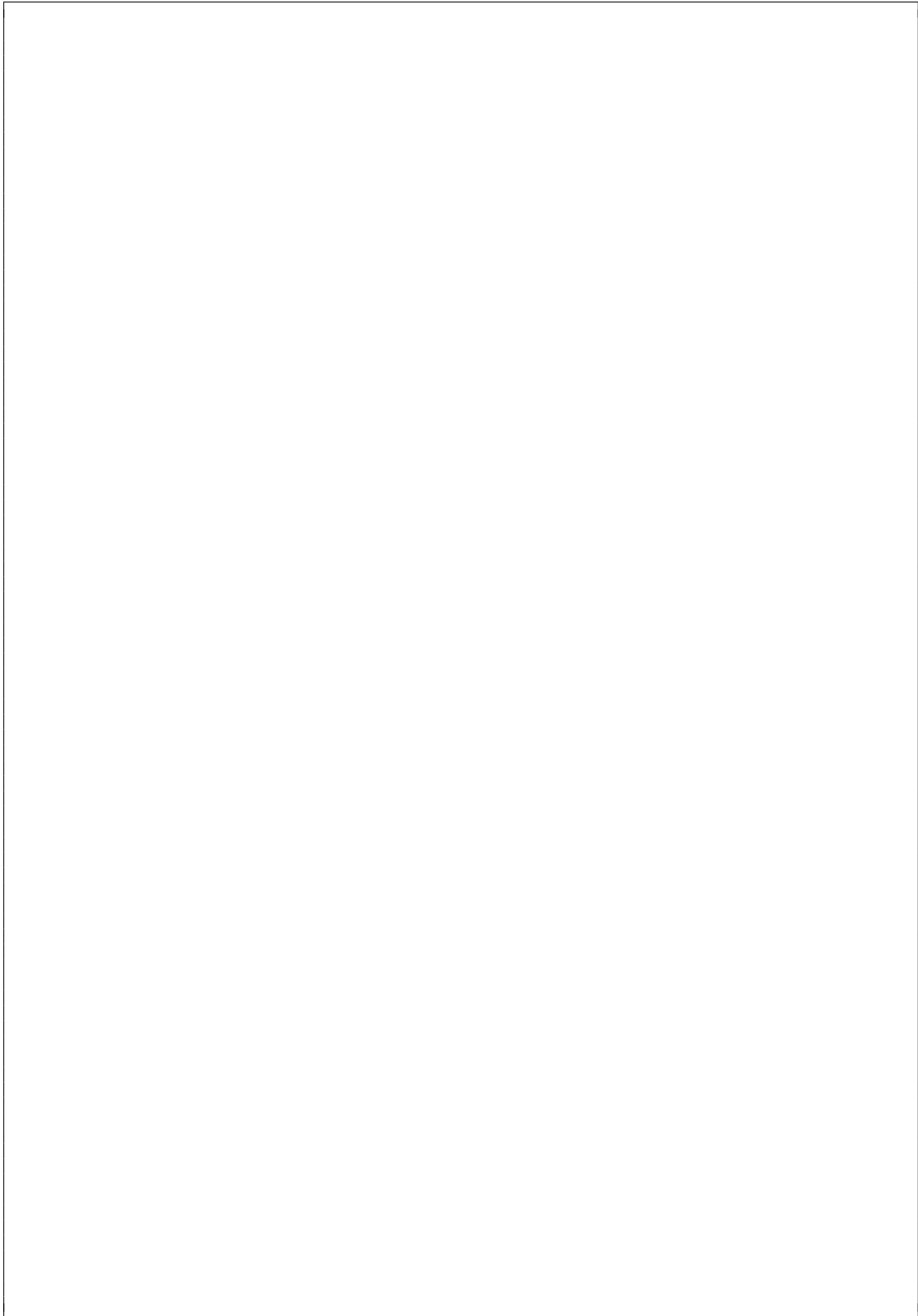
Lesson 5.1

Assuming you followed the methodology suggested in Homework 1, how could generalised maps help you create a model that is valid?
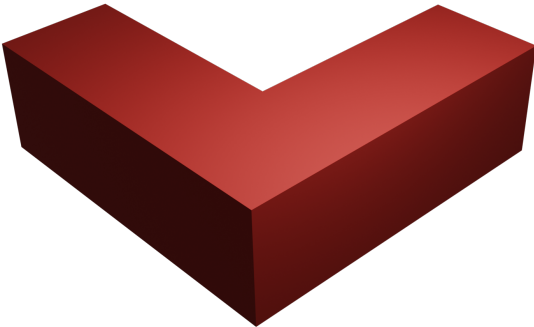
Lesson 5.2

Given a quadratic Bézier curve with point coordinates $(0, 0)$, $(1, 3)$, $(2, 0)$, what coordinates do we obtain when we evaluate it at $t = 0.5$? You should either write the calculation step by step or explain the reasoning you used to come up with the answer.

Lesson 6.1

Draw a CSG tree that produces the building below. You may only use half-spaces as primitives.

Lesson 6.2

You want to re-implement Homework 2 using BIM models as input (instead of an LoD2 3D city model). Describe two significant methodological changes you would need in your code for this to work.

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