TU Delft Delft University of Technology

Faculty of Architecture & the Built Environment

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

Location: AE-Hall E
Date & time: 21 June 2024, 9:00
Responsible teacher: Hugo Ledoux

1. The subject matter is in full accordance with the study guide.
2. This resit exam is worth 50% of the final mark for the course. Your result will replace your previous marks for both the midterm and the final exam.
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 up to 6.0. However, you need at least 50% in this 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 and its back side 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 14 pages.
8. Fill out your name and student ID.
9. You have 2 hours to do this exam.

Name: _____

Student ID: _____

Lesson 1.1

Describe your own implementation of Homework 3 (original or resit) in terms of its handling of geometry, topology and semantics. There should be one statement about each of the three components.

Lesson 1.2

How does a constrained triangulation or tetrahedralisation help you adequately represent objects with holes and cavities? **(a)** Explain it in your own words (½ point) and **(b)** illustrate it with an example (½ point).

Lesson 2.1

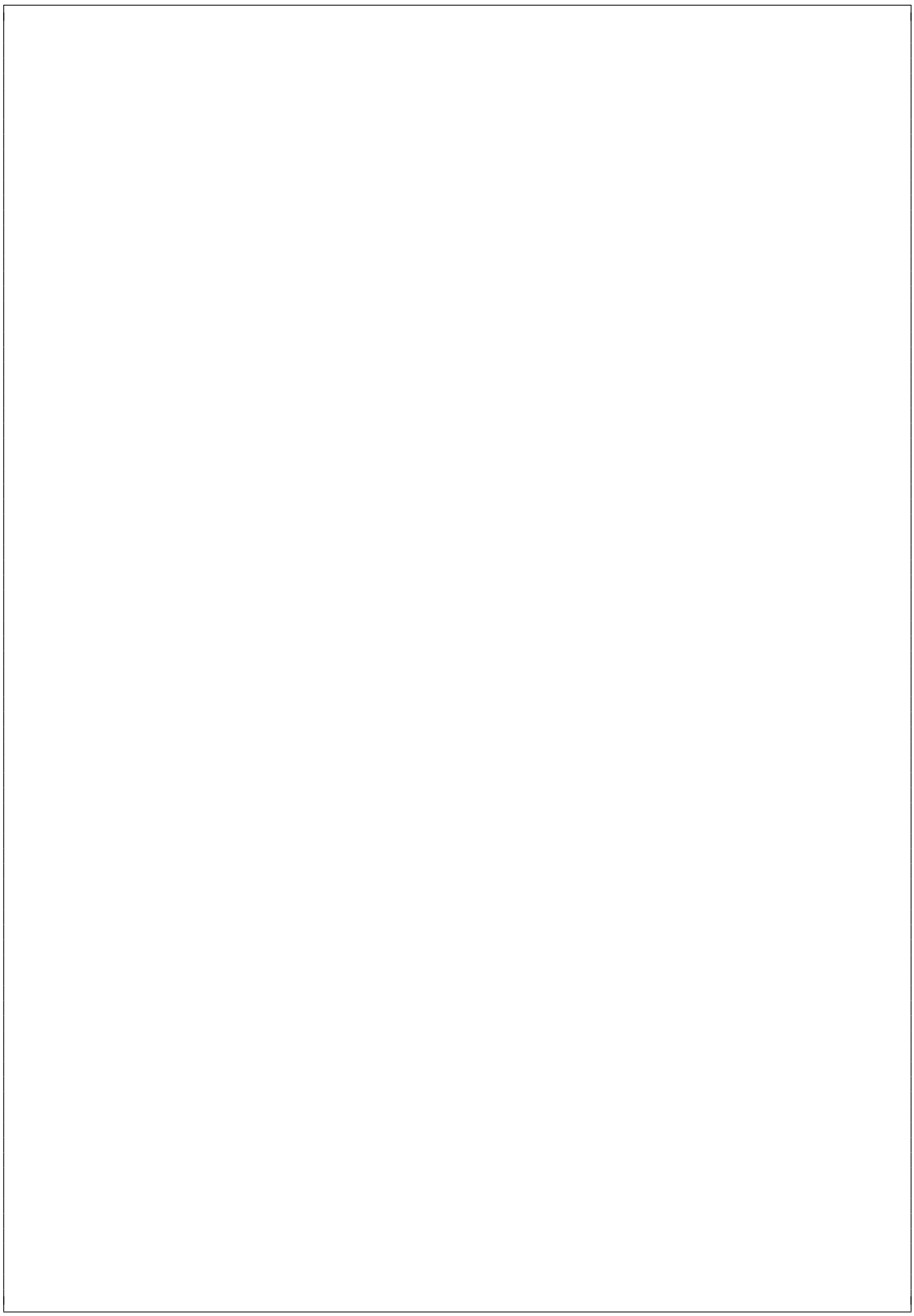
You have a CityJSON file of a building and need to calculate its volume. However, you perform some tests and find out that its geometry is not valid: the building has some intersecting surfaces and holes. Describe one method you could use to obtain a reliable approximation of the volume of it.

Lesson 2.2

Converting surfaces to voxels requires totally different algorithms if the surfaces represent a field's isosurfaces or an object's boundary. Explain why.

Lesson 3.1

Draw two Solids having the same topology, one should be valid according to ISO19107 and the other one should not be (⅓ point each). Explain briefly why the first is valid and why the second is not (⅓ point).

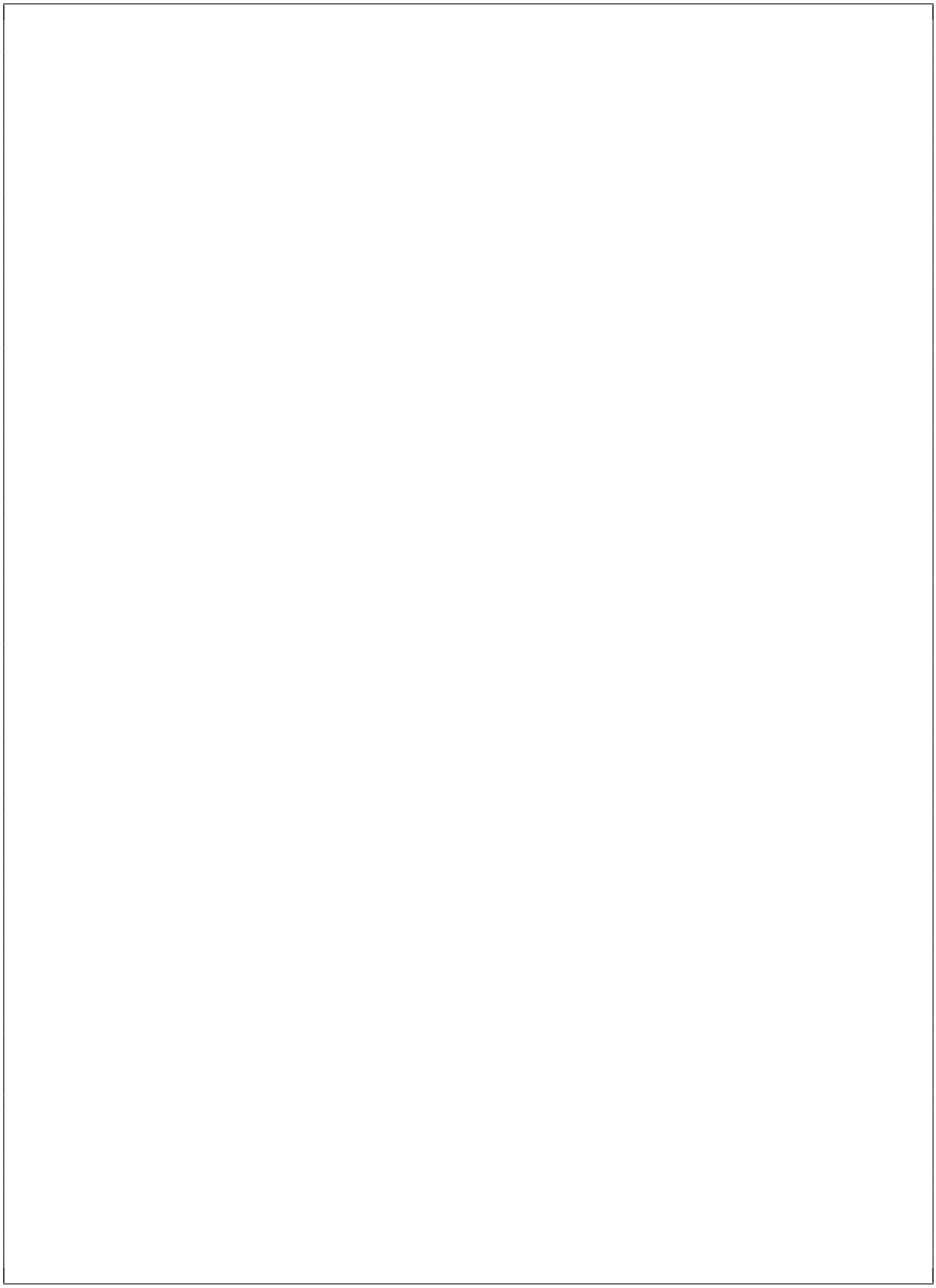


Lesson 3.2

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

You want to apply the reconstruction method from Chapter 12 of the 3D book, but the building footprints are inaccurate. Explain in detail how would this affect the method and the results obtained with it.

Lesson 5.1

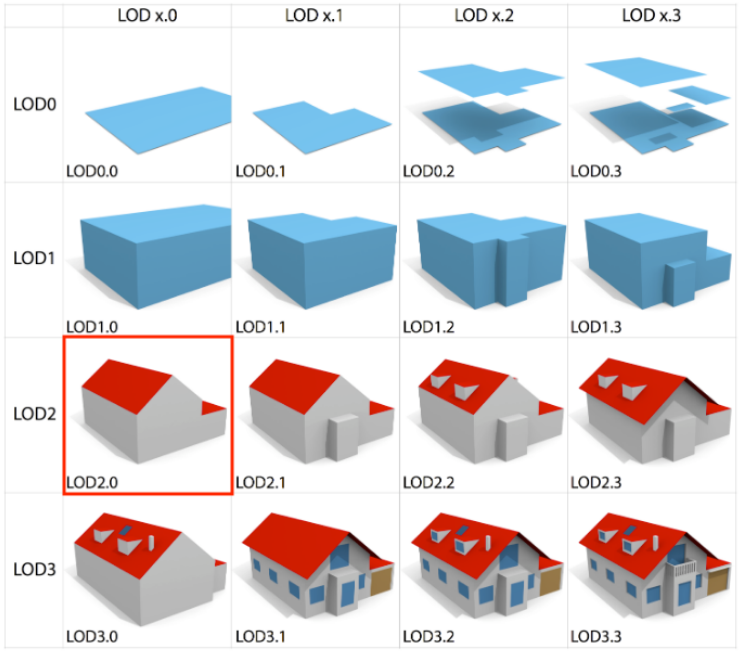
Generalised maps do not have a predefined orientation. Explain concretely how this property could be useful using your own implementation of Homework 1 (original or resit) as an example.

Lesson 5.2

Given a quadratic Bézier curve with point coordinates $(0, 0)$, $(2, 2)$, $(2, 0)$, 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

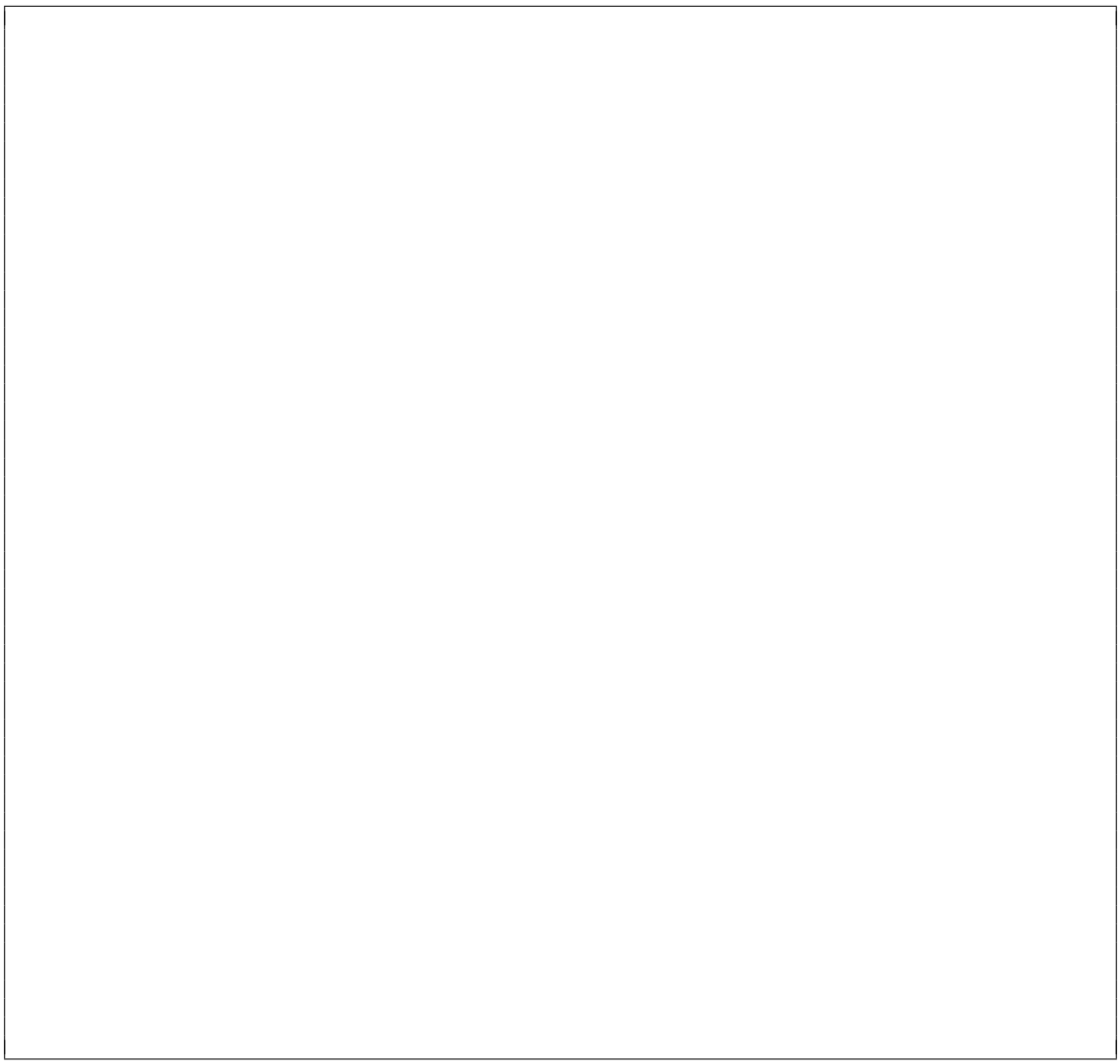
Draw one CSG tree that produces the model from the LOD2.0 panel below. You can only use half-spaces and cuboids (i.e. boxes) as primitives.



Lesson 6.2

Describe what is being represented in this IFC snippet. Provide as much information as you can obtain from it.

```
#206= IFCCARTESIANPOINT((-861.428571428573,-477.142857142857));
#208= IFCCARTESIANPOINT((1878.57142857143,-477.142857142857));
#210= IFCCARTESIANPOINT((1878.57142857143,522.857142857139));
#212= IFCCARTESIANPOINT((28.5714285714302,522.857142857142));
#214= IFCCARTESIANPOINT((-1031.42857142857,522.857142857144));
#216= IFCCARTESIANPOINT((-1031.42857142857,-307.142857142857));
#218= IFCCARTESIANPOINT((-861.428571428572,-307.142857142857));
#220= IFCPOLYLINE((#206,#208,#210,#212,#214,#216,#218,#206));
#222= IFCARBITRARYCLOSEDPROFILEDEF(.AREA.,$,#220);
#223= IFCCARTESIANPOINT((-3412.85714285716,-1121.88894482269,0.));
#225= IFCAXIS2PLACEMENT3D(#223,#19,#17);
#226= IFCEXTRUDEDAREASOLID(#222,#225,#19,2438.4);
#227= IFCSHAPEREPRESENTATION(#74,'Body','SweptSolid',(#226));
#230= IFCPRODUCTDEFINITIONSHAPE($,$,(#227));
#234= IFCSPACE('',#42,'0.1',$,$,#204,#230,'BR',.ELEMENT.,.INTERNAL.,$);
```



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