# Course guide
# 290803 - AADT1 - Advanced Architectural Design Techniques I

**Last modified:** 08/07/2025

**Unit in charge:** Vallès School of Architecture
**Teaching unit:** 753 - TA - Department of Architectural Technology.

**Degree:** MASTER'S DEGREE IN ARCHITECTURAL DESIGN ECOLOGY IN THE DIGITAL AGE (Syllabus 2025). (Compulsory subject).

**Academic year:** 2025 **ECTS Credits:** 5.0 **Languages:** English

## LECTURER

**Coordinating lecturer:** Academic Coordination: Lluís Ortega

**Others:** Course 1: Programming Resources in a Systematic Setting: Dionís Buixadé
Course 2: Advanced Modeling: Enrique Soriano
Course 3: Machine Learning: Lluís Ortega
Course 4: Structural Design and Construction: Marta Domènech and David López

## PRIOR SKILLS

No previous skills required.

## REQUIREMENTS

No previous skills required.

## TEACHING METHODOLOGY

Course 1: Programming Resources in a Systematic Setting
The course is organized in 5 blocks. 1, 2 and 3 will be participative lecture oriented and 4 and 5 will be project-based learning.
Course 2: Advanced Modeling
The course is organized in 4 blocks. All sessions will be based on participatory lecture, cooperative work and project-based learning.
Course 3: Machine Learning
The course is organized in 3 blocks. The first one will be lectured, the other two will be a combination of participative lecture and project-based learning.
Course 4: Structural Design and Construction
Classes will combine lecture format with project-based learning.

## LEARNING OBJECTIVES OF THE SUBJECT

K2.1 Examine advanced design and fabrication techniques in architectural projects.
S5.2 Experiment with the use of digital fabrication technologies in the production of models and mock-ups.
S9.2 Use digital technology critically.
C2.1 Apply all possibilities of digital technology and simulation and prediction models in the creation, development, and evaluation of the architectural project.
C5.1 Develop projects in teams and take on responsibilities in production management.
*k (knowledge); S(Skills); C (Competences)

## CONTENTS

## ADVANCED ARCHITECTURAL DESIGN TECHNIQUES I

**Description:**
Course 1: Programming Resources in a Systematic Setting
• Programming Fundamentals: Introduction to programming languages and their development environments. Python programming in Google Colab and Grasshopper. Initial examples and essential libraries.
• Data Structures and Flow Control: Variables. Python's four core data structures: lists, dictionaries, sets, and tuples. Distinctions between general Python and Grasshopper Python. Introduction to loops.
• Advanced Flow Control & AI Assistance: Mastering loops and control flow. Leveraging AI-assisted coding tools.
• Functions: Defining and utilizing functions for modular code.
• Classes: Object-oriented programming with classes.

Course 2: Advanced Modeling
• Grasshopper Logic and List Management
Data types and parametric relationships
Flattening, grafting, matching structures
Tree management, path mapping, sets
Short assignments on generating responsive geometries
• Geometry Basics – Generation and Analysis
Curves, Surfaces, Meshes
Analysis of geometric quantities
Data visualization
• Form Finding and Optimization
Dynamic relaxation with Kangaroo2
Tension-compression models
Mesh optimization techniques
• Evolutionary Solvers and Algorithmic Thinking
What is an objective function?
Multi-objective optimization with Octopus / Galapagos
Feedback loops with Anemone
Solving real-world problems through algorithmic design

Course 3: Machine Learning
• General intro to ML.
Datasets
Google Colab
Neural Networks
Deep learning
State of the art
• Generative Adversarial Networks: GAN
Training NN
Transfer Learning
Case studies: Pix2pix. StyleGAN
• Stable Diffussion
Intro to ComfyUI

Course 4: Structural Design and Construction
This course is structured as a workshop-style seminar designed to provide students with a comprehensive experience in the experimental development of architectural projects. The main objective is to approach design processes from multiple perspectives, including design, structure, and geometry, with a particular emphasis on integrating materiality from the earliest stages of design.
Students will participate in guided activities within two thematic blocks that combine theoretical content with practical exercises, exploring the relationship between design, structure and construction.
The primary goal of this seminar is to promote conscious and critical design, with a strong focus on materials and their structural behavior. Ultimately, students will not only acquire technical and conceptual skills but also cultivate a critical and experimental mindset to tackle contemporary architectural challenges.
There are 2 thematic blocks:
• Introduction. Mass construction
Traditional spatial systems associated with this type of architecture.
The masonry and the stereotomy.

Material and formal innovation.
New digital tools in architecture.
Introduction to some sustainability concepts.
• Designing compression-only architecture
Introduction to graphic statics and structural design.
Form-finding with graphical statics.
Form-finding software with 3D graphic statics (RhinoVAULT2 + COMPAS)

**Full-or-part-time:** 125h
Laboratory classes: 45h
Self study : 80h

## GRADING SYSTEM

The subject is organized based on four courses. Each as an independent grade. The final grade will be calculated based on the following percentages.
Course 1: Programming Resources in a Systematic Setting (30%)
Course 2: Advanced Modeling (30%)
Course 3: Machine Learning (20%)
Course 4: Structural Design and Construction (20%)

## EXAMINATION RULES.

Course 1: Programming Resources in a Systematic Setting
Grading will be based on two exams (15% each) and two comprehensive practical exercises (35% each).
Course 2: Advanced Modeling
80% Assignments. Each session will include an individual or team-based assignment applying the concepts learned, culminating in a final mini-project.
20% Participation. Based on engagement during class, contributions to discussions, and peer feedback in reviews.
Course 3: Machine Learning
80% Assignments. Each of the two practical blocks will include an individual or team-based assignment concepts learned.
20% Participation. Based on engagement during class, contributions to discussions, and peer feedback in reviews.
Course 4: Structural Design and Construction
The continuous evaluation of the course is conducted through the submission of individual and group assignments, as well as practical exercises, with one assignment corresponding to the first thematic block and two corresponding to the second. The first assignment will contribute a maximum of 3 points (out of 10) to the final course grade, while the second and third ones will each contribute a maximum of 3.5 points.

## BIBLIOGRAPHY

**Basic:**
- Frazer, John. An Evolutionary architecture. London: Architectural Association, 1995. ISBN 1870890477.
- Kilian, Axel. Design Innovation through Constraint Modeling. PhD Thesis. MIT, 2006.
- Pottmann, Helmut; Bentley, Daril. Architectural geometry. Exton, PA: Bentley Institute Press, 2007. ISBN 9781934493045.
- Hensel, Michael; Menges, Achim; Weinstock, Michael. Emergent technologies and design : towards a biological paradigm for architecture. Oxon ; New York: Routledge, 2010. ISBN 9780415493444.
- Allen, Edward; Zalewski, Waclaw. Form and forces : designing efficient, expressive structures. Hoboken, N.J.: John Wiley & Sons, cop. 2010. ISBN 9780470174654.
- Pottmann, Helmut; Bentley, Daril. Architectural geometry. Exton, PA: Bentley Institute Press, 2007. ISBN 9781934493045.
- Ruby, Ilka; Ruby, Andreas; Bridger, Jessica. Re-inventing construction. Berlin : Zurich: Ruby ; Holcim Foundation for Sustainable Construction, 2010. ISBN 9783981343625.
- Ruby, Ilka; Ruby, Andreas. The materials book. Berlin: Ruby Press, 2020. ISBN 9783944074320.
- Tedeschi, Arturo. AAD_Algorithms-aided design : parametric strategies using Grasshopper. Brienza: Le Penseur, cop. 2014. ISBN 9788895315300.

**Complementary:**
- Issa, R.. Essential algorithms and data structures for Grasshopper [on line]. [Consultation: 06/10/2025]. Available on: https://developer.rhino3d.com/guides/grasshopper/gh-algorithms-and-data-structures/.
- Shell structures for architecture : form finding and optimization. London: Routledge, 2014. ISBN 9780415840606.
- McDonough, William. Cradle to cradle : remaking the way we make things. New York: North Point, 2002. ISBN 9780865475878.

## RESOURCES

**Other resources:**
https://www.reddit.com/r/StableDiffusion/ />https://www.reddit.com/r/comfyui/ />https://discord.com/invite/stablediffusion />https://civitai.com/ />https://comfyworkflows.com/
https://openart.ai/workflows/home />