



Project No.
3011

Date
2025

Doc. No.
ARC-3011

Serial No
1/2025

Rev.
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Architecture

EOTSS Doc. CODE :

EOTSS/CIVIL/3011-ARC /2025

المكتب الهندسي لخدمات التكنولوجيا والبرمجيات

Engineering office for Technology and Software Services



Computational Design with Grasshopper for Architects



Course Code: 3011-ARC

Title: Parametric and Environmental Design using Grasshopper and Rhino

Introduction & Description

This course introduces architects and designers to **computational design** using **Grasshopper** for **Rhino**. It bridges the gap between **design and programming**, empowering participants to

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generate and analyze complex architectural forms through **visual scripting**. Participants will gain hands-on experience in parametric modeling, optimization, and connecting design with environmental and structural simulations.

Objectives

- Understand the fundamentals of **computational and parametric design**.
- Create intelligent architectural forms using **visual programming**.
- Integrate **environmental and structural analysis** into the design process.
- Apply **data-driven design thinking** to real-world architectural challenges.

Target Audience

- Architecture professionals and students.
- Interior and urban designers interested in parametric methods.
- Civil engineers and designers exploring environmental & structural optimization.
- Enthusiasts of **digital architecture and generative design**.

Time Frame

- **Duration:** 5 Weeks
- **Total Hours:** 15 hours
- **Format:** Weekly 3-hour sessions (theory + practical)

Detailed Course Outline

Week	Topic	Description
Week 1	Introduction to Rhino	Understanding UI, data structures, and geometry

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Week	Topic	Description
	& Grasshopper	basics
Week 2	Visual Scripting Logic	Inputs, operations, components, lists, and trees
Week 3	Mathematical Modeling & Parametrics	Functions, attractors, and geometric control through equations
Week 4	Environmental & Structural Analysis Integration	Linking with tools like Ladybug/Honeybee, Karamba, and using external data
Week 5	Capstone Project	Design, simulate, and present a responsive architectural model with performance analysis

What You Will Learn

- How to use Grasshopper with Rhino for **parametric modeling**.
- Creating adaptive and data-driven forms using **mathematical functions**.
- Running **performance-based simulations** (e.g., sunlight, wind, structure).
- Exporting data and designs for further architectural development.

Materials Included

- Digital handouts and slides
- Sample Grasshopper scripts
- Rhino & Grasshopper models
- Plugin guides: Ladybug, Karamba, Galapagos

Instruction Format

- Instructor-led live sessions

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- Hands-on practical labs
- Weekly exercises and mini challenges
- Final presentation and feedback session



Detailed Course Outline

Week 1: Introduction to Rhino & Grasshopper

- Overview of computational design and parametric thinking
- Navigating the **Rhino 3D** interface
- Introduction to **Grasshopper**: UI, canvas, and basic components
- Understanding **data types**: numbers, points, vectors, curves
- Creating simple **parametric forms** (walls, towers, panels)

Week 2: Visual Scripting Logic & Data Structures

- Working with **lists**, **data trees**, and hierarchy in Grasshopper
- Introduction to **logical operators** and conditional workflows
- Organizing and managing complex definitions
- Practical exercises on **repetition**, **patterns**, and **modularity**
- Creating re-usable design systems

Week 3: Mathematical Modeling & Form Generation

- Using **mathematical expressions** to control geometry
- **Attractors** and **field-based design** (gravity, magnetism, etc.)
- Implementing **adaptive skins**, dynamic façades, and towers
- **Graph mappers** and **remapping values**

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- Real-world architectural applications

Week 4: Environmental and Structural Integration

- Using plugins:
 - **Ladybug/Honeybee** for solar, daylight, energy simulations
 - **Karamba** for structural stress and deformation analysis
- Connecting parameters with **real-world performance data**
- **Data visualization:** graphs, charts, colored meshes
- Optimizing form based on analysis results

Week 5: Final Project & Presentation

- Design and implement a **parametric architectural model**
- Apply environmental and/or structural analysis
- Document process: sketches, diagrams, scripts
- Present a final video or board showing design logic and performance
- Group review and instructor feedback

✓ Learning Outcomes (What You Will Learn)

By the end of this course, you will be able to:

- **Think parametrically:** Understand how to generate flexible and adaptive architectural forms using data and logic
- **Use Grasshopper confidently** to create and manipulate geometry
- **Apply mathematical and algorithmic control** to design
- **Integrate environmental analysis tools** to evaluate and optimize designs

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-  Connect with **structural analysis tools** like Karamba
-  Build **real-time responsive models** that adapt to context and constraints
-  **Visualize data and performance** metrics in your models
-  Present a **fully parametric and analyzed architectural project**

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