ADVANCED ARCHITECTURAL GEOMETRY

IE University
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Academic year: 22-23
Degree course: FOURTH
Semester: 2º
Category: COMPULSORY
Number of credits: 6.0
Language: English

PREREQUISITES
Students shall be fluent in 3D modelling, preferably in Rhinoceros.
Students are familiar with the use of Grasshopper.
The course assumes all students have completed all the Digital Workshops offered by the School, especially those related to BIM.
Students have their own laptop with the necessary software installed (see below #8)

SUBJECT DESCRIPTION
Advanced Architectural Geometry is an introduction to the practical and rigorous use of Computational and Building Information Modelling techniques for complex projects through the collaboratively development of an architectural competition.

The course focuses on the integration and management of several design variables into a thoughtful and consistent project design workflow by means of parametric 3D modelling, scripting or algorithmic thinking, where the design performance is the main objective.

Building Information Modelling is impacting the way architects approach project delivery: as studios and offices adopt BIM and complex modelling as their core methodology and principal tools they realize that concept and detail design, cost control, programme control and other areas of common practice need to be addressed differently.

BIM and computational modelling enables a more comprehensive and integrated design, where plans, sections, 3D, quantities, structural behavior and business model alignment can be weighed and assessed almost in real time, changes can be solved rapidly, coordination between trades is more transparent and output can be measured closer to the design decisions.

On the promise of fewer errors and a budget under control, delivering projects in a digital environment is becoming mandatory in many countries around the world. Governments, public institutions and leading private companies require this methodology while practices of all sizes struggle to adapt and find the right staff for challenging, global projects.

With the framework of the competition for the design of an Arena, the course will provide students with the skills and mindset necessary to approach a project digitally, under real-world conditions:

- The program brief will be solved comprehensively, with clear output indicators.
- Work will be developed in teams. Competition among teams will be fostered.
- Multidisciplinarity will be a constant requirement.
- Tools like Revit, Dynamo, Rhinoceros, Grasshopper will be used to provide students with resources to solve the complexities of their projects.

OBJECTIVES AND SKILLS

Advance Architectural Geometry aims to equip students with the following competences:

- To acquire knowledge of Advanced Geometry, CAD and BIM practices, including planning, modelling and information management, as a response to the strong requirement expressed by authorities and companies that are enforcing this methodology around the world.
- To understand the ways project information and geometry can be integrated in a design process, not to constraint it but to make it more sound, performance oriented.
- To be able to address a complex project brief, with economic, functional and output requirements entwined with design intentions with the help of digital tools.
- To be able to integrate cost, coordination, comfort and sustainability indicators in their design workflow.
- To learn the basics on how to plan and coordinate the production of an Advanced Geometry project, including execution planning, clash detection, standards curation and automation.
- To learn professional-grade modelling skills with tools like Revit and Rhinoceros and to evaluate multi-variable project decisions with the help of data visualization and and parametric modelling techniques.

Additionally, Per the Decree EDU/2075/2010, 29 of July

Basic Competencies:

CB1: Students have demonstrated knowledge and an understanding of a given area of study, building upon the foundation of secondary education, supported by advanced texts, and including aspects that engage the latest advances in their area of study.

CB2: Students know how to apply their knowledge professionally to their work or vocation and possess the competencies that are often demonstrated through elaboration and defense of arguments and the resolution of problems within their area of study.

CB3: Students can gather and interpret relevant facts (usually within their area of study) in order to make judgments that include reflection on relevant social, scientific, and ethical topics.

CB4: Students can transmit information, ideas, problems, and solutions to both specialized and non-specialized audiences.

CB5: Students have developed the necessary learning skills to continue their studies with a high degree of autonomy.

General Competencies:

CG1: Knowledge of the history and theories of architecture, as well as that of the arts, technologies and human sciences related to the field.

Specific Competencies:

CE48: Adequate knowledge of the general theories of form, composition, and architectural typologies.

CE54: Adequate knowledge of aesthetics, and the history and theory of fine and applied arts.

Crossed Competencies:
CT1: Ability to identify the main characteristics of cultural identities that characterize the contemporary world through the knowledge of central ideological currents.
CT2: Ability to exercise professional behavior in accordance with constitutional principles and ethical values of the respective profession.
CT3: Manage unforeseen situations with the capacity to respond to changes within organizations.
CT4: Use disciplinary knowledge to analyze and evaluate current situations. CT5,
CT5: Integrate oneself into interdisciplinary and multicultural teams to achieve common goals in a context of diversity
CT6: Work actively at in an international context.

METHODOLOGY

Being part of the Studio / Proyectos Module, the course is planned as a competition for the design and delivery of an Arena, a multi-purpose venue with clear economic, iconic, operational and construction constraints. Students will have to propose and solve their design in teams, approaching the project in a layered sequence, solving and fixing variables such as the location, the programme, the expected return on investment, the capacity, the spectator experience and comfort, the structural safety and constructability, all in an integrated manner.

Output parameters will be established and then measured for construction costs, operational costs and operational returns. The course is not a design studio per se, but architectural design quality will also be a key performance parameter.

Teams will then compete with each other to reach the best possible solution, one that balances all the variables at stake and will end with the presentation of their design in a final review with guest jury made of professionals of the field.

The choice of an Arena as the core topic is not by chance. This type of buildings allow their evaluation in very clear terms, as capacity and sightline quality, number of VIP boxes, possible pitch sizes and structural feasibility can be expressed mathematically and allow for checks and optimization.

The competition will be used as workbench for discussing building information modelling techniques that include:

- Execution Planning. Model subdivision and overseas collaboration.
- Project set-up in Revit.
- Seat-bowl design and sightline analysis using Dynamo and Grasshopper.
- Interoperability between applications using open formats like IFC and data exchange using simple workflows and Excel.
- System design and modelling using Rhinoceros wireframes and Revit families.
- Systems coordination using Navisworks and BIMcollab.
- Key indicators scheduling and processing using Revit, Dynamo, Excel and PowerBI.
- Interactive presentation using Revit rendering and others

Course as Workshop

The spirit of the course is to tackle the competition in a fast-track manner, within a short span of time. Thus, the course can be seen as an extended workshop where lectures and software tutorials will be combined with in-class and out-of-class individual and team work.

The workshop will happen along a compressed schedule of days with several sessions, where each day will be used to cover one topic and follow the same briefing - training - discussion - debriefing structure.

The briefing will consist in the presentation of a topic in the form of lectures that introduce the state-of-the-art or a specific problem.

Training will include practical, guided sessions on software and algorithms.
Discussion will be fostered among team members in order to make them advance in the resolution of the competition while in class, sharing with the rest of the class their findings at the end of each day.

Additional home-work will need to be conducted in order to advance with the design, using the tools and methods covered in class.

<table>
<thead>
<tr>
<th>Teaching methodology</th>
<th>Weighting</th>
<th>Estimated time a student should dedicate to prepare for and participate in</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lectures</td>
<td>10.0 %</td>
<td>15 hours</td>
</tr>
<tr>
<td>Discussions</td>
<td>10.0 %</td>
<td>15 hours</td>
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<tr>
<td>Exercises</td>
<td>20.0 %</td>
<td>30 hours</td>
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<td>Group work</td>
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<td>Other individual studying</td>
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</tr>
<tr>
<td>TOTAL</td>
<td>100.0 %</td>
<td>150 hours</td>
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</table>

**PROGRAM**

**SESSIONS 1 - 3 (LIVE IN-PERSON)**

Project Kick-off

**Briefing**

Course presentation. Competition briefing. Locations, business models, markets.

**Training**

Arena design. Flexibility and operation. Project information management best practices.

**Discussion**

Location selection. Budget and ROI statement.

**Debriefing and homework**

- Requirements research
- Arena Business Plan

**SESSIONS 4 - 6 (LIVE IN-PERSON)**

**PERFORMANCE IN DESIGN**

**Briefing**

Performance in architecture. Key metrics in structure, comfort, safety and energy.

**Training**

Resolution of performance problems through parametric modelling. Case studies in Grasshopper and Dynamo.

Massing in Rhinoceros and Grasshopper

**Discussion**


**Debriefing and homework**

24th October 2022
- Arena Business Plan 90%
- Massing Model 30%

SESSIONS 7 - 9 (LIVE IN-PERSON)

Conceptual Modelling

Training
Resolution of performance problems through parametric modelling. Case studies in Grasshopper and Dynamo.
Massing in Rhinoceros and Grasshopper
Facade Modelling in Rhinoceros and Grasshopper

Debriefing and homework
- Business Plan 90%
- Massing Model 60%
- Facade Model 30%

SESSIONS 10 - 12 (LIVE IN-PERSON)

BIM SETUP & INTEROPERABILITY

Briefing

Training
- Revit Setup
- Structure Modelling
- Grandstands Modelling. Driving Revit elements from Rhinoceros wireframes. Bi-directional connection.

Discussion - Work in class
- Structure Modelling
- Arena layout setup.
- Roof modelling.

Debriefing and Homework
- Business Plan 90%
- Massing Model 90%
- Facade Model 30%
- Structure model 30%

SESSIONS 13 - 15 (LIVE IN-PERSON)

PROJECT COORDINATION

Briefing
Use of Links and Basic Collaborative Workflows. Clash detection workflows.

Training
Modelling Architectural Elements
Element classification and costing.

Discussion
Roof structure review.
Arena layout refinement.
Coordination review. Preliminary costing

Debriefing and homework
- Business Plan 90%
- Massing Model 90%
- Facade Model 60%
- Structure Model 60%
- Architecture Model 30%

SESSIONS 16 - 18 (LIVE IN-PERSON)
TEAM WORK
Debriefing and homework
- Business Plan 90%
- Massing Model 90%
- Facade Model 90%
- Structure Model 90%
- Architecture Model 60%

SESSIONS 19 - 21 (LIVE IN-PERSON)
PROJECT DOCUMENTATION
Briefing
Documentation best practices in Revit.
Data extraction and scheduling.

Training
Arena documentation. Line drawings, views and key indicators.

Discussion
Arena documentation.

Debriefing and homework
- Business Plan 90%
- Massing Model 90%
- Facade Model 90%
- Structure Model 90%
- Architecture Model 90%
- Documentation 30%

SESSIONS 22 - 24 (LIVE IN-PERSON)
TEAM WORK

24th October 2022
Debriefing and Homework
- Business Plan 100%
- Massing Model 100%
- Facade Model 100%
- Structure Model 100%
- Architecture Model 100%
- Documentation 60%

SESSIONS 25 - 27 (LIVE IN-PERSON)

PROJECT PRESENTATION

Briefing
Advanced techniques for presentation
Interactive experiences

Training
Project presentation with Revit and Enscape

Discussion
Arena presentation.

Debriefing and homework
- Documentation 90%

SESSIONS 28 - 30 (LIVE IN-PERSON)

FINAL REVIEW

Discussion
Each group to present their final design.
Ranking and trophy ceremony.

EVALUATION CRITERIA

Evaluation will be heavily based on the performance indicators achieved by each group in their respective designs, with additional appreciations on architectural quality of the solution, as esteemed by an independent jury, and the faculty continuous assessment of each team involvement.

As deliverables subject to evaluation, teams will be required to submit:
- A set of BIM models as primary source for all additional design data.
- A set of drawings, views, documents, representing the design in a narrative way.
- A dossier describing each of the design decisions and the performance achieved.

1. Students have access to a total of four enrolments, in two consecutive academic years
2. Students must attend at least 70% of all class sessions. Students who do not meet this minimum percentage automatically fail both first and second enrolments, and pass directly to the third enrolment.
3. Grading of students in the extraordinary enrolments will follow the following guidelines: Students that have fail the subject in first enrolment pass to the second enrolment, except those who do not meet the minimum attendance percentage, and that therefore pass directly to the third enrolment.
4. The maximum grade that a student may achieve in second enrolment is an 8.

24th October 2022
The form of assessment for the 3rd and 4th enrolment will be as an exercise consisting of a development of a smaller Arena that collects all the knowledge acquired during the program and a written report that includes design and development process and result.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Percentage</th>
<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>Design performance</td>
<td>70 %</td>
<td></td>
</tr>
<tr>
<td>Jury evaluation</td>
<td>10 %</td>
<td></td>
</tr>
<tr>
<td>Professor Appraisal</td>
<td>20 %</td>
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</tbody>
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PROFESSOR BIO

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ROBERTO MOLINOS ESPARZA

Roberto Molinos is an architect and holds a Master of Advanced Studies in Structural Design from Madrid Tech - Madrid (ES). He has developed undergraduate research with Rafael Escolá Foundation and POLE Europe program, completing essays on applied use of information technologies in multidisciplinary projects.

Currently, he combines part time teaching at IE University with his work at Modelical, a model-based consultancy for better architecture and engineering projects. Roberto is also promoter of Algomad http://www.algomad.org/, a workshop that seeks to spread the use of computational tools in architectural design.

OTHER INFORMATION

Office Hours: 1 hour after each class plus via email.
Contact Details: rmolinos@faculty.ie.edu

Software and Hardware Requirements

The course has a technical spirit and thus requires the use of diverse software and tools.

Students are required to follow the course with their PC laptops and will have to make sure all the necessary software and permits are installed and working before the course commences.

Autodesk Revit 2023 - https://www.autodesk.com/education/free-software/revit
Rhinoceros 7.0 64bits - www.rhino3d.com
Dynamo 2.0 - http://dynamobim.org
Grasshopper - www.grasshopper3d.com
Google Sheets account (included with your IE Student Google Account)
PowerBI - http://powerbi.microsoft.com (optional)

Liquid Learning

Covid-19 has brought us a world that we thought only lived in fiction. In the School of Architecture and Design, we understand the current crisis as an opportunity to imagine a new pedagogy, one that explores new paths in architecture education that go beyond any contingency. Concomitant with this idea, IE University introduced the concept of Liquid Learning as a response to the times we live at as well as strengthening the quality of education. In this new Liquid Learning environment, students on-site and online, and considering status changes throughout time, will receive the same quality of education due to the revision of our pedagogical methods and application of new technologies to make the new environment feasible to ensure the best experience.
In order to execute this plan, some changes will be introduced within the teaching methodology, the most important of them, the organization of the courses through synchronous and asynchronous sessions. To make definitions clear, synchronous sessions refer to those sessions where students and professors coincide in time, although they might or might not, coincide in space. This means that during these sessions the students might be sharing Studio with the professor, or might be remote although present at the same time thanks to the technologies that will allow those students to be part of the Studio activities. Asynchronous sessions will be those where professors and students do not coincide in time nor space. During these sessions, the interaction between professors and students, and among students, will be produced in different ways, such as project portfolio reviews, detailed feedback, lectures, and other activities that will be explained below.

ADDITIONAL MATERIALS

Basic Bibliography