APPLIED MATHEMATICS IN ARCHITECTURE 2

IE University
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Academic year: 22-23
Degree course: SECOND
Semester: 1<sup>o</sup>
Category: BASIC
Number of credits: 3.0
Language: English

PREREQUISITES
Applied Mathematics in Architecture I.
Basic knowledge of Rhinoceros 3D.

SUBJECT DESCRIPTION
Contemporary architecture is designed predominately with digital software, different digital tools encourage distinct workflows, which have critical impact over design outcomes. This course explores three-dimensional geometry processing, while simultaneously providing an introduction in traditional differential geometry. The focus is on understanding the relevance of form as a product of exploring the reciprocity between math and computation. This dual perspective enriches understanding on both sides, and leads to the development of practical algorithms for working with real-world geometric data.

OBJECTIVES AND SKILLS
Along the course concepts of linear algebra, transformations, curves and surfaces classifications and multivariable calculus will be revisited, putting a strong emphasis on intuitive, visual understanding that complements the more traditional formal treatment. The course provides essential mathematical knowledge applied to a large array of real-world examples and applications. The course will be based on the introduction to the visual programming language Grasshopper within the software Rhinoceros. In each session the students will learn the fundamental knowledge of math that they will apply it in coding trough Grasshopper, visualising that they learn. They will learn how to describe the topological continuity of any shape through equations, translating differential geometry into a language suitable for computation.

(Per Ministerial Decree EDU/2075/2010, 29 of July; and the official accreditation request for the Bachelor in Architectural Studies, July 2015)

BASIC AND GENERAL OBJECTIVES
- 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.

SPECIFIC COMPETENCIES

- CE11: Applied knowledge of numerical calculus, analytic and differential geometry, and algebraic methods.

TRANSVERSE COMPETENCIES OF THE UNIVERSITY

- CT4: Use disciplinary knowledge to analyze and evaluate current situations.

METHODOLOGY

Each session has a distinct theme, an exploration of a distinct aspect of differential geometry and traditional surfaces. The sessions begin with a theory talk or demonstration, but the bulk of our time is be spent actively working through a series of exercises/tutorials. Students will utilize both digital and physical media. Teaching throughout the course will be based on learning through exploration and experimentation from numbers to form.

Out of the 17 sessions:
- 8 sessions are dedicated to lectures.
- 2 sessions are dedicated to multi choice tests based on what the students learned.
- 7 sessions are dedicated to in class applications of concepts learned during the course.

Students are asked to follow along the tutorials on their own computers.

<table>
<thead>
<tr>
<th>Teaching methodology</th>
<th>Weighting</th>
<th>Estimated time a student should dedicate to prepare for and participate in</th>
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</thead>
<tbody>
<tr>
<td>Lectures</td>
<td>33.33 %</td>
<td>25 hours</td>
</tr>
<tr>
<td>Discussions</td>
<td>13.33 %</td>
<td>10 hours</td>
</tr>
<tr>
<td>Exercises</td>
<td>26.67 %</td>
<td>20 hours</td>
</tr>
<tr>
<td>Group work</td>
<td>0.0 %</td>
<td>0 hours</td>
</tr>
<tr>
<td>Other individual studying</td>
<td>26.67 %</td>
<td>20 hours</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100.0 %</td>
<td>75 hours</td>
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PROGRAM

SESSIONS 1 - 2 (LIVE IN-PERSON)

Affine Transformations
Application of the concepts previously learned through visual programming.

SESSIONS 3 - 4 (LIVE IN-PERSON)
Non-Linear Transformations
Application of the concepts previously learned through visual programming.

Assignment 01 OUT – Computational Patterns (20% of the grade).

SESSIONS 5 - 6 (LIVE IN-PERSON)

Parametric Curves

Evaluating Curves
Application of the concepts learned through visual programming.

SESSIONS 7 - 8 (LIVE IN-PERSON)

Parametric Surfaces

Evaluating Surfaces
Application of the concepts learned through visual programming.

Assignment 01 DUE – Computational Patterns (20% of the grade).

SESSIONS 9 - 10 (LIVE IN-PERSON)

Motion Surfaces
Application of the concepts learned through visual programming.

Assignment 02 OUT – A Catalogue of Surfaces (30% of the grade).

SESSIONS 11 - 12 (LIVE IN-PERSON)

Advanced Surfaces
Application of the concepts learned through visual programming.

SESSIONS 13 - 15 (LIVE IN-PERSON)

Assignment Review
Students are expected to explain the concept they want to develop, bringing drawings and diagrams. References and guidance will be given based on the needs and directions of each proposal. Peer-reviews will take place at the end of the session.

SESSIONS 16 - 17 (LIVE IN-PERSON)
Final Exam
Multichoice test (40% of the grade). It will contain exercises on:
- Matrices Operations and Transformations.
- Parametrized Curves and Surfaces.
- Curves and Surfaces Evaluation.
- Surface Creation: Extrusion, Translational, Revolution, Swept Surfaces.
- Loft, Patch, Ruled, Minimal, Tangent Surfaces.

Assignment 02 DUE - A Catalogue of Surfaces (30% of the grade).

BIBLIOGRAPHY
Recommended


- George L. Legendre. Pasta By Design. ISBN 9780500515808 (Digital)

EVALUATION CRITERIA
A. CLASS PARTICIPATION
Three main criteria will be used in reaching judgment about your class participation:
- Depth and Quality of Contribution: the comments and questions must be relevant to the topic discussed in class. Students are encouraged to ask questions when something remains unclear to them. It is appreciated if students attempt to respond the questions of their peers and help them move forward.
- Frequency: Frequency refers to the attainment of a threshold quantity of contributions that is sufficient for making a reliable assessment of comment quality. your attempts at participation should not be such that the instructor has to “go looking for you”. You should be attempting to get into the debate on a regular basis.

B. FINAL EXAM
The students will have to successfully complete 1 multi-choice final exam based on what they learned in all the course. For better results, students are asked to pay attention and take notes during class.

C. HOMEWORK EXERCISES AND ASSIGNMENTS
The course relies on an application that requires the student to work outside the class. The details of what these submissions imply will be discussed in detail in class and are mention above in the course program. The final grade is based on continuous evaluation throughout the course.

21th June 2022
D. FINAL GRADE
The final grade breakdown:

- Sobresaliente/Outstanding: 9.0-10.0 (A to A+). Consistently produces work of the highest quality and craft; exhibits notable progress and development over the course of the semester; meets all course objectives at highest level; attendance is near-perfect, and contributions to course discussions are extremely valuable.
- Notable: 7.0-8.9 (B to B+). Completes all assignments with work of above-average quality and craft; exhibits significant progress and development; meets most course objectives; attendance and participation are very good.
- Aprobado: 6.0-7.0 (C to C+). Completes all assignments with work of acceptable quality and craft; exhibits some progress and development; meets a majority of course objectives. Attendance and participation are acceptable.
- Aprobado: 5.0-6.0 (D). Assignments are delivered but are incomplete and/or of low quality and craft; exhibits little progress and development; meets few course objectives. Attendance and participation are poor, but absences do not total more than 30%.
- Suspenso: 0-4.9 (F). Work is incomplete, missing, or does not meet course objectives. Attendance and participation are poor.
- Automatic Failure/Suspenso: 0 (F). Please note that a student who misses 30% or more of the scheduled sessions receives an automatic 0.0, and loses his or her right to the second “convocatoria.”

E. RETAKE POLICY

- Each student has 4 chances to pass any given course distributed in two consecutive academic years (regular period and July period).
- Students who do not comply with the 70% attendance rule will lose their 1st and 2nd chance, and go directly to the 3rd one (they will need to enrol again in this course next academic year).
- Grading for retakes will be subject to the following rules: Students failing the course in the first regular period will have to do a retake in June (except those not complying with the attendance rules, which are banned from this possibility). Dates and location of the June retakes will be posted in advance and will not be changed. Please take this into consideration when planning your summer. The maximum grade that a student may obtain in any type of retake will be 8 out of 10. The retakes will consist on a comprehensive exam. The grade will depend on the performance in this exam and on the assignments submission; continuous evaluation over the semester will not be taken into account.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Percentage</th>
<th>Comments</th>
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<tbody>
<tr>
<td>Final Exam</td>
<td>40 %</td>
<td></td>
</tr>
<tr>
<td>Class Participation</td>
<td>10 %</td>
<td></td>
</tr>
<tr>
<td>Assignments</td>
<td>50 %</td>
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PROFESSOR BIO

Professor: ALESSANDRO MATTOCCIA
E-mail: amattoccia@faculty.ie.edu

21th June 2022
Alessandro is a co-founder of 50SuperReal studio, where he focuses on applying coding to the automatisation of design and technical processes, as well as playing the role of BIM Manager and computational expert.

He is currently an adjunct professor at IE School of Architecture and Design where he teaches Mathematics and Computational Geometry, Co-Director at Structuralia in the Master “BIM and Smart Buildings” as well as professor in the “Programming applied to BIM” Master programe.

Alessandro spends a lot of his time in educational processes, giving lectures, workshops and corporate training programs. Previously, he has been teaching in ETSAM as part of the Masters in Advanced Infographics, and you can find his online classes on several different educational and profesional platforms. He has also been a researcher in the Institute of Advanced Architecture of Catalonia, focusing on urban scale projects, and part of MargenLab team designing and building architectural prototypes based on energy modelling and sustainable strategies.

Currently he is focusing his career in pushing the boundaries of the Building Information Modelling methodology. Processes as advanced modelling, automatisation and data informed geometry are his main topics of research, mixing programming and drafting to explore the digital capabilities of architecture and design.

Alessandro graduated cum laude in 2015 from the Faculty of Engineer in Pisa with a master degree in “Building Engineering and Architecture”, presenting a project that studied the intersection between vernacular architecture and information technologies, which can be found in several publications. Through exchange programs, he has also studied at the Technical University of Riga and the Institute of Advanced Architecture of Catalonia (IAAC). In 2016 he enrolled the International Master BIM Manager from Zigurat, Global Institute of Technology.

OTHER INFORMATION
Students are required to bring their own laptop with a mouse and a sketchbook to each class. Students who fail to do so will be marked as “Absent”.

All students must have Rhinoceros 3d and the Grasshopper plug-in pre-installed, before the course starts.