APPLIED PHYSICS IN ARCHITECTURE 1

IE University
Professor: LUIS ECHEVARRIA GIMENEZ
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Academic year: 22-23
Degree course: FIRST
Semester: 2º
Category: COMPULSORY
Number of credits: 6.0
Language: English

PREREQUISITES

SUBJECT DESCRIPTION

The objective of Applied Physics in Architecture I is to provide the student with tools for understanding the physical principles with which to analyse the stability and the statics of any structure or structural element.

The way to introduce the student in the matter is through an intuitive and holistic vision before approaching the essential mathematical algorithms.

The classes that students attend, in which the theoretic content is presented, are complemented with practical individual work, which are intended to give the student some cognitive and attitudinal skills that will be of great use to take on, with security, a professional career.

The formal learning is complemented with practices, media tools and individual workshops, trying to provide the student with the knowledge and attitude to face a professional career.

Therefore, the objective of the course is not limited to prepare the student for further courses matters, such as installations, structures, materials and construction. It is also organized to encourage students to follow the concepts, suggesting them how study must be undertaken and how to find information and face the workshops.

OBJECTIVES AND SKILLS

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.

CG4: An understanding of the fundamental issues in structural design, construction, and engineering as related to building projects, as well as the techniques used to address these issues.

CG5: Knowledge of the issues related to building physics, technologies, and programmatic uses, in order to create buildings that provide internal comfort and protection from the elements.

SPECIFIC COMPETENCIES:

CE7: Adequate knowledge of the fundamental principles of mechanics, statics, mass point geometry and vector and tensor fields, as applied to architecture and urbanism.

TRANSVERSE COMPETENCIES OF THE UNIVERSITY:

CT4: Use disciplinary knowledge to analyze and evaluate current situations. In this course, we will emphasize the fundamentals of architectural vocabulary, and an introduction to the key movements, contexts, and elements in the discipline of architecture. We will therefore place special emphasis on the specific competencies CE7, described above.

METHODOLOGY

The subject is focused on the physics and mathematical principles on which structures are based.

Traditional methodology consists on explaining the mathematical and physical principles at early stages so students are soon capable of solving problems of ideal situations, most of them separated from the reality.

The approach of this subject aims to start with a real case, to deal with its physics particularities and to learn how to use the proper mathematical tools to meet their resolution.

The learning will be supported by a varied range of problems and practical examples to illustrate the concepts, and the resolution of exercises and problems to illustrate the physical and mathematical principles on which the theory is based.

Based on the competences described above, the Professor will rely for his class sessions on a combination of the below course formats:

- Lectures, to explain the theory of new concepts
- Development of practical exercises for the correct understanding of the subject

Based on the competences described above, students will dedicate their individual study hours to:

- Individual study
- Preparation of assignments

<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>26.67 %</td>
<td>40 hours</td>
</tr>
<tr>
<td>Discussions</td>
<td>6.67 %</td>
<td>10 hours</td>
</tr>
<tr>
<td>Exercises</td>
<td>40.0 %</td>
<td>60 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>40 hours</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100.0 %</td>
<td>150 hours</td>
</tr>
</tbody>
</table>

PROGRAM

31th October 2022
SESSION 1 (LIVE IN-PERSON)
PRESENTATION OF THE SUBJECT AND INTRODUCTION TO MECHANICS
Description of the contents of the subject, of the objectives sought and the teaching methodology used; the form in which the knowledge of the student will be evaluated and recommendations on how to create an efficient method of working.

SESSION 2 (LIVE IN-PERSON)
INTERNATIONAL SYSTEM OF UNITS. CHANGE OF UNITS
Description of the International System of Units. Base Units, Derived Units, Metric Prefixes. Change of units. Exercises

SESSION 3 (LIVE IN-PERSON)
FORCE SYSTEMS

SESSION 4 (LIVE IN-PERSON)
MOMENTS AND THEIR CHARACTERISTICS.

SESSION 5 (LIVE IN-PERSON)
COUPLES

SESSION 6 (LIVE IN-PERSON)
RESULTANT OF FORCES

SESSION 7 (LIVE IN-PERSON)
CENTROID AND CENTER OF GRAVITY
SESSION 8 (LIVE IN-PERSON)
MOMENT OF INERTIA
Determination of moments of inertia manually. The transfer formula. Exercises.

SESSION 9 (LIVE IN-PERSON)
MOMENT OF INERTIA

SESSION 10 (LIVE IN-PERSON)
DISTRIBUTED LOADS
Exercises

SESSION 11 (LIVE IN-PERSON)
EQUILIBRIUM OF RIGID BODIES

SESSION 12 (LIVE IN-PERSON)
EQUILIBRIUM OF RIGID BODIES
Equilibrium in two and three dimensions. Exercises.

SESSION 13 (LIVE IN-PERSON)
INTRODUCTION TO INTERNAL FORCES
Internal and external forces and moments. Tension, compression, bending moments, shear forces and torsion. Stress and strain. Exercises.

SESSION 14 (LIVE IN-PERSON)
AXIALLY LOADED MEMBERS

SESSION 15 (LIVE IN-PERSON)
TUTORSHIP

SESSION 16 (LIVE IN-PERSON)
MID-TERM EXAM

SESSION 17 (LIVE IN-PERSON)
BENDING MOMENTS AND SHEAR FORCES
Bending moment. Deflection. Diagram of bending moments for standard cases. Shear concept. Shear stress. Relationship between load, shear forces and bending moments with punctual forces.
SESSION 18 (LIVE IN-PERSON)
BENDING MOMENTS AND SHEAR FORCES

SESSION 19 (LIVE IN-PERSON)
DISTRIBUTED FORCES AND BENDING MOMENTS AND SHEAR FORCES
Shear Forces and Bending moment when distributed forces are applied. Diagram of bending moments for standard cases.

SESSION 20 (LIVE IN-PERSON)
DISTRIBUTED FORCES AND BENDING MOMENTS AND SHEAR FORCES
Shear Forces and Bending moment when distributed forces are applied. Deflection. Diagram of bending moments for standard cases. Exercises.

SESSION 21 (LIVE IN-PERSON)
ELASTICITY

SESSION 22 (LIVE IN-PERSON)
PLASTICITY
Ultimate Strength. Perfect plasticity and Hardening plasticity. Exercises.

SESSION 23 (LIVE IN-PERSON)
STRESS STRAIN DIAGRAM

SESSION 24 (LIVE IN-PERSON)
DEFLECTION
Exercises.

SESSION 25 (LIVE IN-PERSON)
NORMAL STRESS IN BENDING
Neutral axis. Stress in the cross-sectional area. Exercises.

SESSION 26 (LIVE IN-PERSON)
COMBINATION OF NORMAL FORCES AND BENDING MOMENT
Distribution of stresses in a section subjected to axial force and moment. Exercises
SESSION 27 (LIVE IN-PERSON)
RESISTANCE OF A CROSS SECTION
Exercises

SESSION 28 (LIVE IN-PERSON)
Exercises

SESSION 29 (LIVE IN-PERSON)
TUTORSHIP

SESSION 30 (LIVE IN-PERSON)
FINAL EXAM

BIBLIOGRAPHY
Recommended
- Gordon, J. E.. *Estructuras o Por Qué Las Cosas No Se Caen.* Calamar ediciones. ISBN 9788496235068 (Printed)

EVALUATION CRITERIA

6.1. GENERAL CONSIDERATIONS
Students will be evaluated continuously over the course of the semester, taking into account attendance and student commitment and participation in class, as well as the completion of written assignments.

The minimum attendance allowed will be that established in the IE University regulations: those students who don't attend at least 70% of all sessions will fail the course with a 0,0 and will proceed directly to third enrollment. Students that have failed the subject in first enrollment pass to the second enrollment, except those who do not meet the minimum attendance percentage.

For those attending the second extraordinary exam period, the maximum grade a student may achieve in second enrollment is 8.

6.2 GRADING STANDARDS
According to IE University policies, the students will be evaluated on a scale from 1 to 10. The standards of each grades are described below:

- 1, 2, 3, 4: Not passing level of work -- significant areas needing improvement and/or incomplete or insufficient deliverables to evaluate student properly.
- 5: Minimum acceptable passing level of work with several areas needing critical improvement, and/or the further development of deliverables.
- 6: Fair level of work with some areas needing improvement.
- 7: Consistent, solid work during the whole semester. The student producing what is expected at that year level.
- 8: Advanced level of work for what can be expected at that year level.
- 9: Exceptional level of work, highly advanced for the student’s year level. Starting at the grade of 9, the student may (according to the necessary consensus among professors) receive “Honors / Matricula de Honor/Honors” as a recognition of an exceptional work.
- 10: Beyond exceptional level of work, within the standards of a much higher year level.

<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>Demonstrate adequate understanding of the structural principles dealt with in classes</td>
</tr>
<tr>
<td>Mid-Term Exam</td>
<td>20 %</td>
<td>Demonstrate adequate understanding of the structural principles dealt with in classes</td>
</tr>
<tr>
<td>Intermediate tests and assignments</td>
<td>30 %</td>
<td>Average between intermediate tests and assignments</td>
</tr>
<tr>
<td>Class Participation</td>
<td>10 %</td>
<td>Attendance and active participation in class activity</td>
</tr>
</tbody>
</table>

Students have access to a total of four enrollments, in two consecutive academic years. Students must attend at least 70% of all class sessions. Students who do not meet this minimum percentage automatically fail both first and second enrollments, and pass directly to the third enrollment.

Students that have failed the subject in first enrollment pass to the second enrollment, except those who do not meet the minimum attendance percentage, and that therefore pass directly to the third enrollment.

**Ordinary Examination (1st exam session):**

Requirement: A minimum qualification of a 4.0 in the mid-term exam and the final exam must be obtained, in order to pass the subject.

For all students who fulfill the university’s attendance requirements (which is a minimum of a 70%), final assessment will be the weighted average of the aspects related above. If the obtained qualification is not equal or superior to 5.0, the student will have to do the extraordinary examination (2nd exam session). Students with a percentage of class attendance inferior to 70% will be assessed directly on the 3rd and 4th exam sessions.

**Extraordinary Examination (2nd exam session):**

The student will have to attend a full examination of the subject. The final grade of the this examination will be the maximum of the extraordinary exam and the weighted average of the extraordinary examination (60%), intermediate tests and assignments (30%) and class participation (10%). The maximum grade that a student may achieve in second enrollment is an 8.

**Ordinary and Extraordinary Examinations (3rd and 4th exam sessions):**

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For those students that are on the 3rd and 4th exam sessions, the evaluation system will follow the same criteria. Taking into account the fact that they might not be able to attend the sessions regularly, they will be provided with the course material via e-mail or on the on-line campus. However, all cases will be studied individually at the beginning of the course.

PROFESSOR BIO

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Professor Luis Echevarría is a Civil Engineer who studied at the University of La Coruña where he graduated in 2010 with a final mark of “Matrícula de Honor”. He is now following his studies in order to obtain a doctorate in Civil Engineer.

Echevarría began working in 2010 as a Civil Engineer at the Eduardo Torroja Institute of Construction Science, a public institution under the Spanish National Research Council, where he works as a researcher in the fields of structures and materials used in construction and structural pathology.

OTHER INFORMATION

Calculators are not provided at the test, and you can’t share a calculator. Bring Your Own Calculator

If you have a calculator with characters that are one inch or higher, or if your calculator has a raised display that might be visible to other test-takers, you will be seated at the discretion of the teacher. Only battery-operated, handheld equipment can be used for testing. No power cords are allowed.

You will be dismissed and your scores canceled if you use your calculator to share information during the test, or to remove test questions or answers from the test room.