APPLIED PHYSICS IN ARCHITECTURE 1

Bachelor in Architectural Studies BAS SEP-2023 P1-AS.1.S.A

Area Architecture and Design

Number of sessions: 30

Academic year: 23-24

Degree course: FIRST

Number of credits: 6.0

Semester: 2º

Category: COMPULSORY

Language: English

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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.

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SUBJECT DESCRIPTION

The objective of Applied Physics in Architercture 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.

LEARNING OBJECTIVES

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.

TEACHING 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

Learning Activity	**Weighting**	**Estimated time a student should dedicate to prepare for and participate in**
Lectures	26.67 %	40.0 hours
Discussions	6.67 %	10.0 hours
Exercises in class, Asynchronous sessions, Field Work	40.0 %	60.0 hours
Group work	0.0 %	0.0 hours
Individual studying	26.67 %	40.0 hours
TOTAL	100.0 %	150.0 hours

PROGRAM

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.

Introduction to Mechanics. Fundamental quantities: Newton’s Laws and their application to Statics. Basic concepts: mass, weight, force and unit weight.

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

Definition of force and force system. Forces and their characteristics: magnitude, direction, point of application, line of action. Scalar quantity. Vector quantity. Types of vector. Principle of transmission. Classification of forces. Classification of force systems. Simplification of a force system: resultants. Resultant of concurrent forces. Vector operations for scalar and vector quantities: addition, subtraction. Resolution into components. Rectangular components. Exercises.

SESSION 4 (LIVE IN-PERSON)

MOMENTS AND THEIR CHARACTERISTICS.

Concept of the moment of a force applied to a body, mathematical fundamentals of momentum, vectorial representation. Concept of moment of a force. Lever arm. Principle of moments: Varignon's Theorem. Moment of a force about a point.

SESSION 5 (LIVE IN-PERSON)

COUPLES

Couples. Moment of couples. Resolution of a force into a force and a couple. Coplanar and non-coplanar force systems. Moment of a force about a point, moment of a force about an axis. Exercises.

SESSION 6 (LIVE IN-PERSON)

RESULTANT OF FORCES

Equivalent systems. Coplanar force systems. Noncoplanar, parallel force systems. Exercises.

SESSION 7 (LIVE IN-PERSON)

CENTROID AND CENTER OF GRAVITY

Centre of gravity. Centroids. Concept of symmetry. Concept of gravity in a body of one two and three dimensions. Calculations of gravity in symmetrical figures. Centre of gravity in compound figures. Distributed loads on beams. Exercises.

SESSION 8 (LIVE IN-PERSON)

MOMENT OF INERTIA

Determination of moments of inertia manually. Exercises.

SESSION 9 (LIVE IN-PERSON)

MOMENT OF INERTIA

Moment of inertia of composite areas. Analysis of catalogues. The transfer formula. Exercises.

SESSION 10 (LIVE IN-PERSON)

DISTRIBUTED LOADS

Equivalent force of a distributed load. Exercises

SESSION 11 (LIVE IN-PERSON)

EQUILIBRIUM OF RIGID BODIES

Types of equilibrium. Free-body diagram. Types of supports and connections: roller, pinned, fixed support. Reactions. Equilibrium equations. Exercises.

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. Exercises.

SESSION 14 (LIVE IN-PERSON)

AXIALLY LOADED MEMBERS

Effects produced by internal forces. Normal force diagrams. Exercises.

SESSION 15 (LIVE IN-PERSON)

TUTORSHIP

SESSION 16 (LIVE IN-PERSON)

MID-TERM EXAM

SESSION 17 (LIVE IN-PERSON)

SHEAR FORCES

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

Bending moment. Diagram of bending moments for standard cases. Relationship between load, shear forces and bending moments with punctual forces. Exercises.

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

Yield Strength. Hooke's Law. Young Modulous. Exercises

SESSION 22 (LIVE IN-PERSON)

PLASTICITY

Ultimate Strength. Perfect plasticity and Hardening plasticity. Exercises.

SESSION 23 (LIVE IN-PERSON)

STRESS STRAIN DIAGRAM

Stress - Strain diagram of different materials. Axial resistance of a cross-section. Partial security factor.

SESSION 24 (LIVE IN-PERSON)

DEFLECTION

Concepts. Ways of calculating. 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

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'tt attend at least 80% 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.

criteria	**percentage**	**Learning Objectives**	**Comments**
Final Exam	40 %		Demonstrate adequate understanding of the structural principles dealt with in classes
Intermediate tests and assignments	30 %		Average between intermediate tests and assignments
Mid-Term Exam	20 %		Demonstrate adequate understanding of the structural principles dealt with in classes
Class Participation	10 %		Attendance and active participation in class activitie

RE-SIT / RE-TAKE POLICY

Students have access to a total of four enrollments, in two consecutive academic years.

Students must attend at least 80% 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):

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. Please contact with the teacher to see the availability of the attendace and the dates of the exams.

BIBLIOGRAPHY

Recommended

- Limbrunner, G.F. and Spiegel, L.. *Applied Statics and Strength of Materials.* Pearson International Edition. ISBN 0133840549 (Printed)
- Wiliam F. Riley and Leroy D. Strurges. *Engineering Mechanics. Statics.* Wiley. ISBN 0471053330 (Printed)
- Robert L. Ketter, George C, Lee and Sherwood P. Prawel Jr.. *Structural Analysis and Design.* Mcgraw-Hill. ISBN 0070342911 (Printed)
- Warren C. Young and Richard G. Budinas. *Roark's Formulas for Stress and Strain.* Mcgraw-Hill. ISBN 9781260453751 (Printed)
- E. Torroja. *Razón y Ser de los Tipos Estructurales.* Consejo Textos universitarios. ISBN 9788438003701 (Digital)
- Gordon, J. E.. *Estructuras o Por Qué Las Cosas No Se Caen.* Calamar ediciones. ISBN 9788496235068 (Printed)

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Please, check the University's Code of Conduct here. The Program Director may provide further indications.

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