ADVANCED STRUCTURES AND FOUNDATIONS

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 enrolled in this course should have successfully completed Applied Physics in Architecture 1, Mathematical Foundations in Architecture, and Structural Types and Calculations 1 & 2.

SUBJECT DESCRIPTION
Advanced Structures and Foundations is the final theoretical course in the building structures series of the Bachelor in Architectural Studies. The course will build on knowledge gained in earlier structures courses, primarily Structural Types and Calculations 1 & 2, and will expand the students' competencies in structural and foundation design by focusing on the following advanced topics:

1. Design of building structures in steel, reinforced concrete and timber
2. Appraisal and retrofit of existing structures
3. Conceptual design of structural foundations

An applied approach will be used in developing these topics, with regular practical exercises and case studies that will help students consolidate structural design skills.

OBJECTIVES AND SKILLS

2.1- 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.

CG6: Knowledge of the industries, organizations, regulations, and procedures needed in order to transform projects into buildings, and to integrate drawings into the planning process.

2.2- SPECIFIC COMPETENCIES:

CE12: Ability to devise, calculate, design and implement foundation solutions, and to integrate them into buildings and urban assemblies (W).

CE13: Ability to apply technical and constructive codes and regulations.

CE14: Ability to preserve building structures, foundations and public works.

CE17: Capacity to develop, calculate, design, and execute building structures, and to integrate them into buildings and urban complexes (W).

CE24: Adequate knowledge of the mechanics of solids, continuous media and soil, as well as the plastic, elastic, and resistance qualities of heavy building materials.

In addition, special emphasis will be placed on Ability to devise, calculate, design and implement foundation solutions, and to integrate them into buildings and urban assemblies. Furthermore, ability to design and realize controlled experiments and to interpret the results will be developed during the course.

2.3- TRANSVERSE COMPETENCIES OF THE UNIVERSITY

CT2: Ability to exercise professional behavior in accordance with constitutional principles and ethical values of the respective profession.

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

CT5: Integrate oneself into interdisciplinary and multicultural teams to achieve common goals in a context of diversity.

METHODOLOGY

The course is divided into three blocks of contents. Each block will be delivered through a mix of lectures, case-study workshops and individual exercises, following a common application-based methodology.

Content blocks will begin with the delivery of theoretical contents in lectures, supported by individual exercises to be done by the students in their individual study time. Each block will involve a case-study workshop or visit, where real buildings, structures and laboratory experiments will be discussed and analysed.

Throughout the course students will have to develop an individual structural design project for a building. This will entail the selection of an appropriate structural system and material, the design of effective structural layouts and the dimensioning of key structural elements with the aid of a structural analysis package. Students will receive support on their designs through a series of workshops where each of the relevant steps will be presented and discussed, both individually and as a group.

ATTENDANCE: The minimum attendance allowed will be that established in the IE University regulations: those students that do not attend at least 70% of all sessions will fail the course with a 0,0 and will proceed directly to third enrollment. Students who arrive more than 5 minutes late for class shall be marked absent. Students that have failed the subject in first enrollment pass to the second enrollment, except those who do not meet the minimum attendance percentage.
<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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<tbody>
<tr>
<td>Lectures</td>
<td>22.0 %</td>
<td>33 hours</td>
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<tr>
<td>Discussions</td>
<td>8.0 %</td>
<td>12 hours</td>
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<tr>
<td>Exercises</td>
<td>33.33 %</td>
<td>50 hours</td>
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<tr>
<td>Group work</td>
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<td>0 hours</td>
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<tr>
<td>Other individual studying</td>
<td>36.67 %</td>
<td>55 hours</td>
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<tr>
<td>TOTAL</td>
<td>100.0 %</td>
<td>150 hours</td>
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**PROGRAM**

**SESSION 1 (LIVE IN-PERSON)**

Introduction to the course: Outline, learning objectives, evaluation methods. The module design assignment will be introduced, including the workplan for the term (submissions and tutorials)

**SESSION 2 (LIVE IN-PERSON)**

**Conceptual design of building structures**

The design of efficient and well integrated building structures departs from a concept that is developed in combination with the architecture. This session will look in depth at this process and will offer a methodological approach for considering the building structure, its form and material from building concept.

**DESIGN OF BUILDING STRUCTURES**

**SESSIONS 3 - 4 (LIVE IN-PERSON)**

**Workshop: conceptualising structural systems**

This session will recap on key structural materials and their main properties and characteristics, linking them to relevant structural systems. A workshop-style session, it will include work in pairs to define structural layouts for different architectural proposals.

**SESSIONS 5 - 6 (LIVE IN-PERSON)**

**Design of Steel structures**

Design and dimensioning of steel structural elements: beams, columns and connections.

**SESSIONS 7 - 8 (LIVE IN-PERSON)**

**Design of timber structures**

Dimensioning of timber structural elements: beams, columns, walls and slabs. Types of connections.

**SESSIONS 9 - 10 (LIVE IN-PERSON)**
Design of concrete structures
Design of reinforced concrete sections in linear elements: beams and columns

SESSIONS 11 - 12 (LIVE IN-PERSON)
Workshop: first workshop on individual structural design projects
Selection of appropriate structural system and material(s). Addressing possible layouts.

SESSIONS 13 - 14 (LIVE IN-PERSON)
Site visit: intervention on existing building

SESSIONS 15 - 16 (LIVE ONLINE)
Building Structures Case Studies Session

SESSIONS 17 - 18 (LIVE IN-PERSON)
Understanding Existing Building Structures
Why existing building structures matter. Surveying, investigating and monitoring existing structures. Typical interventions when adapting an existing building for a new use.
Existing masonry structures

SESSIONS 19 - 20 (LIVE ONLINE)
Existing timber structures
Existing structures: modern materials
Concrete and metal existing structures. Pathologies and assessment. Intervention strategies.

EXISTING STRUCTURES

SESSIONS 21 - 22 (LIVE ONLINE)
Workshop: second workshop on individual structural design projects.
Finalising the proposed structural system and layout. Pre-dimensioning of key elements.

SESSIONS 23 - 24 (LIVE IN-PERSON)
Recap on foundations for buildings structures: Main foundation typologies, their design and types of soils.
In this session we will recap key foundations concepts covered in previous structures courses, including the main foundation typologies used for building structures and the primary structural materials employed for each typology, followed by the most common types of soils.
Fundamentals of soil behaviour

31th October 2022
The two sessions on Fundamentals of Soil Behaviour will present the basics of soil mechanics, including bearing capacity, settlement and flow through soils, as well as ground investigations, in order to provide an understanding of ground engineering principles that serve as a basis for the design of buildings structures.

*Book Chapters: Ch 8: Below-ground structures. In Building Structures: Understanding the basics (Book) (CED)*

**CONCEPTUAL DESIGN OF STRUCTURAL FOUNDATIONS**

**SESSIONS 25 - 26 (LIVE ONLINE)**

Fundamentals of soil behaviour: continued
The two sessions on Fundamentals of Soil Behaviour will present the basics of soil mechanics, including bearing capacity, settlement and flow through soils, as well as ground investigations, in order to provide an understanding of ground engineering principles that serve as a basis for the design of buildings structures.

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Laboratory experiments: soil testing

**SESSIONS 27 - 28 (LIVE ONLINE)**

Workshop: Third workshop on individual structural design project.
A workshop using CYPE or equivalent structural analysis package to assist on dimensioning structural elements.

**SESSION 29 (LIVE IN-PERSON)**

Foundations case study session

**SESSION 30 (LIVE ONLINE)**

Final exam

**BIBLIOGRAPHY**

Compulsory
  This book is available in an online version only and can be acquired via: https://www.istructe.org/resources/guidance/conceptual-design-of-buildings/
  This book is available in an online version only and can be acquired via: https://onlinelibrary.wiley.com/doi/book/10.1002/9780470691816

31th October 2022

**Recommended**

**EVALUATION CRITERIA**

Evaluation will have two components: an individual design project and an exam.

The individual design project is heavily hands-on and will require continued engagement and evaluation. Students will have check points throughout the term when they will need to submit completed steps towards their design.

The exam will be an opportunity to further demonstrate understanding and competency of the course materials.

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<thead>
<tr>
<th>Criteria</th>
<th>Percentage</th>
<th>Comments</th>
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<tbody>
<tr>
<td>Examen Final</td>
<td>40 %</td>
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<tr>
<td>Individual Work</td>
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**PROFESSOR BIO**

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**ALEJANDRA ALBUERNE RODRÍGUEZ**

Dr Alejandra Albuerne is an architectural engineer with a decade of professional experience in the field of structural design for architecture. She has practiced in London and Madrid in firms such as Arup and Mecanismo. Within structural engineering, Alejandra specialises in existing and historic structures. Before joining IE, Alejandra has taught at the University of Oxford and at The Bartlett (UCL).

**OTHER INFORMATION**

**ADDITIONAL MATERIALS**


[https://historicengland.org.uk/images-books/publications/drawing-for-understanding/](https://historicengland.org.uk/images-books/publications/drawing-for-understanding/)

VVAA. Essential Knowledge Series. Institute of Structural Engineers.