ADVANCED STRUCTURES AND FOUNDATIONS

Bachelor in Architectural Studies BAS SEP-2023 ASF-AS.4.M.A

Area Architecture and Design

Number of sessions: 30

Academic year: 23-24

Degree course: FOURTH

Number of credits: 6.0

Semester: 2º

Category: COMPULSORY

Language: English

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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 strcuctural engineering, Alejandra specialises in existing and historic structures. Before joining IE, Alejandra has taught at the University of Oxford and at The Bartlett (UCL).

Office Hours

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SUBJECT DESCRIPTION

Advanced Structures and Foundations is the final theoretical course in the 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 and dimensioning of building structures in steel, reinforced concrete and timber
2. Conceptual design of structural systems for complex architectures
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.

LEARNING OBJECTIVES

Per Ministerial Decree EDU/2075/2010, 29 of July; and the official accreditation request for the Bachelor in Architectural Studies, July 2015; see BOCYL, 14 March 2018: p. 10477-10481.

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.

TEACHING METHODOLOGY

IE University teaching method is defined by its collaborative, active, and applied nature. Students actively participate in the whole process to build their knowledge and sharpen their skills. Professor's main role is to lead and guide students to achieve the learning objectives of the course. This is done by engaging in a diverse range of teaching techniques and different types of learning activities such as the following:

Learning Activity	**Weighting**	**Estimated time a student should dedicate to prepare for and participate in**
Lectures	20.0 %	30.0 hours
Discussions	2.0 %	3.0 hours
Exercises in class, Asynchronous sessions, Field Work	8.0 %	12.0 hours
Group work	23.33 %	35.0 hours
Individual studying	46.67 %	70.0 hours
TOTAL	100.0 %	150.0 hours

PROGRAM

SESSIONS 1 - 2 (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)

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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. Case studies will be explored to discuss different structural schemes and approaches to structural design.

SESSIONS 3 - 4 (LIVE IN-PERSON)

Design of concrete structures 1

Design of reinforced concrete structures. Recap from earlier courses, including typologies and analysis. Advanced analysis of RC structures, including computational modelling and analysis.

DESIGN OF BUILDING STRUCTURES TO CTE AND EUROCODE

SESSIONS 5 - 6 (LIVE IN-PERSON)

Design of concrete structures 2

Design of reinforced concrete structures. Advanced analysis of RC structures: progress with computational modelling and analysis.

SESSIONS 7 - 8 (LIVE IN-PERSON)

Sustainability Topics:

- Environment

Design of Steel structures 1

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

SESSIONS 9 - 10 (LIVE IN-PERSON)

Sustainability Topics:

- Environment

Design of Steel Structures 2

Dimensioning of steel structural elements.

Design of concrete structures 3

Progress with modelling and design of RC structural project.

SESSIONS 11 - 12 (LIVE IN-PERSON)

Sustainability Topics:

- Environment

Design of Timber Structures

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

SESSIONS 13 - 14 (LIVE IN-PERSON)

Sustainability Topics:

- Environment

Design of Timber Structures 2

Dimensioning of timber sections.

Building Structures Case Studies

An invited structural designer will present relevant case studies with a focus on integration of structural system and architecture, discussing how to advance from concept to construction.

SESSIONS 15 - 16 (LIVE IN-PERSON)

Sustainability Topics:

- Environment
- Economic Development

Site visit

SESSIONS 17 - 18 (LIVE IN-PERSON)

Sustainability Topics:

- Environment

Workshop I: individual structural design projects

Selection of appropriate structural system and material(s). Addressing possible layouts.

SESSIONS 19 - 20 (LIVE IN-PERSON)

Sustainability Topics:

- Environment
- Social Challenge

Interventions in Existing Building Structures

Common approaches and interventions on existing building structures

SESSIONS 21 - 22 (LIVE IN-PERSON)

Sustainability Topics:

- Environment

Fundamentals of soil behaviour

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: Building Structures: Understanding the basics (Ch 8: Below-ground structures) (CED

CONCEPTUAL DESIGN OF STRUCTURAL FOUNDATIONS

SESSIONS 23 - 24 (LIVE IN-PERSON)

Sustainability Topics:

- Environment

Retaining structures

Main typologies and structural principles of underground retaining walls.

Workshop II: invidual structural design projects.

Refining structural proposals. Pre-dimensioning of key elements.

SESSIONS 25 - 26 (LIVE IN-PERSON)

Sustainability Topics:

- Environment
- Economic Development

Design of shallow foundations

Design of deep foundations

Main foundation typologies, their design and types of soils.

In this session we will recap key foundations concepts covered in previous structures courses, and will expland to consider main foundation typologies used for building structures and essential selection criteria, followed by design principles.

SESSION 27 (LIVE ONLINE)

Sustainability Topics:

- Environment
- Economic Development

Foundations case study session

An invited structural designer will present relevant case studies of foundations and underground structures, with a focus on the relevance of these elements for the overall architectural design and construction.

SESSION 28 (LIVE IN-PERSON)

Final exam

SESSIONS 29 - 30 (LIVE IN-PERSON)

Sustainability Topics:

- Environment

Workshop III: individual structural design project.

Focus: generating structural drawings.

EVALUATION CRITERIA

Evaluation will have three components: a group modelling project, an individual design project and a final exam.

The group modelling project will take place in the first half of term. Students will work in pairs or small groups to model and analyse a building structure.

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.

criteria	percentage	Learning Objectives	Comments
Final Exam	40 %		Competency in the dimensioning of structural sections
Individual Work	45 %		Competency in the design and representation of structural systems
Group Work	15 %		Competency in the design of RC structures

RE-SIT / RE-TAKE POLICY

BIBLIOGRAPHY

Compulsory

- J Norman et al. (2020). *Conceptual Design of Buildings.* The Institution of Structural Engineers. ISBN 9781906335427 (Digital)

This book is available in an online version only and can be acquired via:

https://www.istructe.org/resources/guidance/conceptual-design-of-buildings/

- M. Millais. (2017). *Building Structures: Understanding the basics.* 3º. Routledge. ISBN 9781138119758 (Digital)

- Eberhard Möller. (2022). *Manual of Structural Design. Structural Principles – Suitable Spans – Inspiring work.* Detail. ISBN 9783955535650 (Printed)

Recommended

- M. Williams and J. Todd. *Structures: Theory and Analysis.* Macmillan. ISBN 9781349907892 (Digital)

- Guy Nordenson. (2016). *Reading Structures: 39 Projects and Built Works. 1983-2011.* Lars Müller Publishers. ISBN 978303778472 (Digital)

- M Forsyth. (2007). *Structures and Construction in Historic Building Conservation.* Blackwell Publishing. ISBN 9781405111713 (Digital)

This book is available in an online version only and can be acquired via:
https://onlinelibrary.wiley.com/doi/book/10.1002/9780470691816

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