# STRUCTURAL TYPES AND CALCULATION 2

**Bachelor in Architectural Studies BAS SEP-2023 STC2-AS.3.S.A**

Area Architecture and Design

Number of sessions: 30

Academic year: 23-24

Degree course: THIRD

Number of credits: 6.0

Semester: 2º

Category: COMPULSORY

Language: English

Professor: **JAVIER GIMENEZ VILA**

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Javier Giménez Vila studied a Masters Degree in Civil Engineering finishing the Structural Design and Urban Planning curricula. Then, he completed a year as international exchange student at Technische Universität Berlin participating in the Massivbau department.

He joined Incosa Investigación y control de calidad S.A. full Junior Design Engineer in 2008. He participated actively on a great variety of structural projects including structural integrity projects. In 2010 he moved to Madrid and began working by Instituto Eduardo Torroja de las Ciencias de las construcción (National Research Council-CSIC) as research engineer focused on structures made of fiber reinforced plastics. During 2010 and 2011 he completed a Master in Structural Engineering and Materials at the Universidad Politécnica de Madrid. From 2011 to 2013 Javier worked at Modelical in a multidisciplinary team collaborating in the architectural design process and integrating new technologies to the construction process. He joined Fhecor Ingenieros Consultores as R&D Engineer developing advanced calculation software, taking part in research projects on structural behavior and participating in complex structural projects. Now he is responsible for Civil engineering and Structual Projects at Modelical and since 2015 is a member of the BIM Task Group of ACHE (Asociación Científico Técnica del Hormigón Estructural).

## Office Hours

Office hours will be on request. Please contact at:

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## SUBJECT DESCRIPTION

The Structures subjects studied in the 2nd course of Architecture (Structural Types I and Structural Calculation I) have familiarized and introduced students to the design of building structures and its language. Starting from very simple structures, all internal forces have been analyzed as well as the stresses and strain they cause. This classic starting point is necessary to introduce students to the framework of the theory of structures.

The subject on Structures for the 3rd year (Structural Types And Structural Calculation II) IS intended to show the overall behavior of structures, using more complex structures, based on architectural examples whose structural behavior is considered interesting. The subject is raised together with continuity in the contents and as a necessary extension of the knowledge acquired in the previous course.

The aim of the 3rd year subject on Structures is the understanding of the global behavior of the structures, but above all, to be able to use the knowledge on structures as a fundamental tool when designing, acquiring a "structural intuition" that allows the development of a common language with structural consultants.

## 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 | 26.67 % | 40.0 hours |
| Discussions | 6.67 % | 10.0 hours |
| Exercises in class, Asynchronous sessions, Field Work | 26.67 % | 40.0 hours |
| Group work | 6.67 % | 10.0 hours |
| Individual studying | 33.33 % | 50.0 hours |
| TOTAL | 100.0 % | 150.0 hours |

## PROGRAM

## SESSIONS 1 - 2 (LIVE IN-PERSON)

INTRODUCTION:

- Presentation of faculty members
- Introduction to 3rd year structures courses and aims to be achieved.
- Recap of previous related courses.

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

LINEAR ELEMENTS

- Cables: Definition, basic concepts and applications in structures.
- Cables: calculation of the reactions and shape of cables subjected to point loads .Cables subjected to distributed loads.

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

LINEAR ELEMENTS

- Cables: Dimensioning
- Arches: basic concepts, funicular and antifunicular shape. Calculation of reactions and bending force diagrams in arches.

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

LINEAR ELEMENTS

- Beams: Statically indeterminate structures. Deformations. Buckling.
- Beams: Dimensioning.

## SESSIONS 9 - 10 (LIVE IN-PERSON)

Form Finding Workshop

Part I: Design

Workshop to understand how form finding works using visual programing tools (Grasshopper) and dynamic relaxation software (Kangaroo). Theory and practical exercises.

## SESSIONS 11 - 12 (LIVE IN-PERSON)

LINEAR ELEMENTS:

- Columns: types and instabilities.

Midterm recap:

- Questions & Exercises

## SESSIONS 13 - 14 (LIVE IN-PERSON)

Midterm Examination

Form finding workshop design review. Feddback and discussion on students designs.

## SESSIONS 15 - 16 (LIVE IN-PERSON)

LINEAR ELEMENTS:

- Columns: Dimensioning.
- Trusses: basic concepts, parts and types.

## SESSIONS 17 - 18 (LIVE IN-PERSON)

LINEAR ELEMENTS:

- Trusses: calculation by method of joints and Ritter's method.
- Trusses: Dimensioning.

## SESSIONS 19 - 20 (LIVE IN-PERSON)

Form finding workshop

Part II: Physical Model testing

Testing of the designs built by the students.

## SESSIONS 21 - 22 (LIVE IN-PERSON)

SURFACE -ACTIVE

- Plates: basic concepts and internal forces of plates.
- Walls: walls as bearing structures.
- Membranes: basic concepts. Internal forces and differences with linear elements
- Shells: basic concepts. Internal forces and differences with linear elements

## SESSIONS 23 - 24 (LIVE IN-PERSON)

ADAPTIVE REUSE OF BUILDINGS

- Case Studies
- Structural analysis: Interaction between existing and new structural systems

## SESSIONS 25 - 26 (LIVE IN-PERSON)

HEIGHT-ACTIVE

- Principles and particularities
- Structural scheme of buildings
- Loads on buildings: recap and influence of height in load conditions
- Skyscrapers: structural types

Structural design according to building code CTE

## SESSIONS 27 - 28 (LIVE IN-PERSON)

Visit to IETcc

Physical tests on Beams. Results analysis.

## SESSION 29 (LIVE IN-PERSON)

Course Recap:

Questions & Exercises

## SESSION 30 (LIVE IN-PERSON)

Final examination

## EVALUATION CRITERIA

Each student has the possibility to complete the course along 4 consecutive evaluation calls.

The minimum assistance of a 80% of the sessions is compulsory. Students with an inferior attendance are not allowed to complete the couse on the first and second evaluation calls, and will directy attempt the third call.

Students who fail the subject on the first call, have a second call chance, except for those who do not meet the minimum an attendance, who will directly attempt the third call.

The maximum mark a student may obtain on the second call is an 8.00.

Students will be expected to complete a number of exercises during the course to work on individually and hand in for assessment before the following sessions. Assignments are compulsory and will count towards the final mark for the course.

Other tutorials related to specific sessions may also be given if necessary to consolidate understanding of the concepts being dealt with in the lectures.

There will also be a midterm examination and a final exam in the last sessions, assessing the students' performance in the course. There may also be polls or control evaluations.

Evaluation of the students' performance in the course will consist of the following:

**Ordinary Examination, first evaluation call**

*Assistance*

A minimum score of 80% for this component of the final evaluation is required.

*Exercises*

They will count for 40% of the final evaluation mark. Exercises will be given after each session, and students must complete these individually and hand in before the following session.

The deadline for the submission of exercises must be respected, and can only be postponed under exceptional justified circumstances. Exercises that are handed in late will count as not submitted, and will have no qualification.

*Group activities*

They will count for 10% of the final evaluation mark. Group activities will focus on the concepts presented during the workshop. An exercise will be given after the workshop. This exercise will be developed by groups of three students.

*Examinations*

There will be a midterm examination and a final exam in the last sessions, assessing the students' performance in the course. In general, the final grade for the examinations will be the average of the midterm and the final exams. The contetns of the midterm will cover the first part of the course. For the final, the student can choose the contents covered: the second part of the course or the whole course. In the second case, the grade for the examinations will be the grade obtained in the final exam.

A minimum grade of 5.00 on each examination is required to consider the average. When this condition is not met, the final grade for the examinations will be the smallest grade between midterm and final.

The examinations grade will count for a 50% of the final evaluation.

If the resulting mark is 5.00 or higher, the student will be adjudged to have successfully completed the course. If the resulting mark is less than a 5.00, students will have to sit the extraordinary examination.

**Extraordinary Examination, second evaluation call**

For those students who do not meet the requirements mentioned above, if they have an assistance record of more than 80% during the course, will have a further opportunity to qualify for satisfactory completion of the course. Those qualifying for this option will need to sit a global examination covering the full contents of the course, as well as complete all the exercises and assignments done during the course.

The final mark will be the result of the following weight: global exam counts 75%. The remaining 25% is the result of assignments (individual exercises) and works submitted during the course.

The maximum mark a student may obtain on the second call is an 8.00.

**Ordinary and Extraordinary Examinations, third and forth evaluation calls**

For those students that are on the 3rd and 4th exam sessions, the evaluation system will follow the same criteria. A minimum of a 80% attendance to session also applies. However, if these sessions overlap with other subjects, the case will be studied individually. 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.

| criteria | percentage | Learning Objectives | Comments |
|---|---|---|---|
| Individual Work | 40 % | | Tutorials and exercises |
| Workgroups | 10 % | | Group activities |
| Final Exam | 50 % | | Written examination |

**RE-SIT / RE-TAKE POLICY**

## BIBLIOGRAPHY

### Recommended


- Heino Engel. (1998). *Structure Systems.* 3rd. Hatje Cantz Publishers. ISBN 9783775707060 (Printed)
- JE Gordon. (1991). *Structures – or why things don't fall down.* Kindle edition. Penguin Books. ISBN 9780140136289 (Digital)
- Daniel L. Schodek & Martin Bechthold. (2013). *Structures.* Pearson. ISBN 9780132559133 (Digital)
- Derek Seward. (2014). *Understanding Structures.* 5th. Red Globe Press. ISBN 9781137376565 (Digital)


## BEHAVIOR RULES

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

## ATTENDANCE POLICY

Please, check the University's Attendance Policy here. The Program Director may provide further indications.

## ETHICAL POLICY

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