Course guide
310709 - 310709 - Introduction to Structures

Unit in charge: Barcelona School of Building Construction
Teaching unit: 753 - TA - Department of Architectural Technology.
Degree: BACHELOR'S DEGREE IN ARCHITECTURAL TECHNOLOGY AND BUILDING CONSTRUCTION (Syllabus 2019).
(Compulsory subject).
Academic year: 2022 ECTS Credits: 6.0 Languages: Catalan, Spanish

LECTURER

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PRIOR SKILLS

The students have to be able to:
Get the solicitations of any section of an isostatic structure.
Formulate the rod solicitations laws and draw the corresponding diagrams.
Formulate the Hooke's Law and solve simple elasticity problems.
Determine the gravity centre of a plain surface.
Get the inertia momentum of a plain surface regarding the main central axis.
Define the concept of radius of gyration of a plain surface regarding an axis and calculate its value.

REQUIREMENTS

Is recommended to have passed the Mecànica and Fonaments Matemàtics.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. FE-15 Aptitude for the pre-measuring, design, calculation and verification of structures and manage its materials execution.

Transversal:
4. SELF-DIRECTED LEARNING - Level 2: Completing set tasks based on the guidelines set by lecturers. Devoting the time needed to complete each task, including personal contributions and expanding on the recommended information sources.
TEACHING METHODOLOGY

The subject is developed over 15 weeks at the rate of:

- 2 hours per week of face-to-face class in the classroom (large group / total 30 hours).
- 2 contact hours per week of practice in the classroom (medium groups / total 30 hours).
- 6 hours per week of autonomous work of the student or student (total 90 hours).
- 6 hours devoted to assessment sessions (3 hours for an intermediate written test or tests, plus 3 hours for the final exam in non-teaching time).

The teaching methodology is fundamental:
(i) Expository and participatory classes in large group classes – avoiding, as far as possible, the expository method such as lectures.
(ii) Execution of activities that allow to achieve and deepen the learning objectives: Resolution and delivery by the students and correction and evaluation by the teacher of both exercises and problems manually or with the help of specific software and activity reports - attending conferences, reading articles and extracts from recommended and guided bibliography, carrying out practices with small-scale models, planning and monitoring or carrying out laboratory practices or solving problems with new technologies by introducing specific software , among others-. This is how it aims to promote both cooperative learning through teamwork - groups of 3 to 5 members - as well as personal study and reflection in individual work. The autonomous work of the students is guided, oriented and supervised by the teacher. The student will have the necessary documentation on the virtual campus and/or in the School's library.

LEARNING OBJECTIVES OF THE SUBJECT

At the end of the course, the student must be able to:

- Know the basic scheme of the structural design and calculation procedure, the approach to the structural safety requirements and the requirements of the idealization process of the structure, the approach to the hypotheses of actions, and the intuitive descent or load path.
- Obtain arithmetically and graphically the laws of variation of forces of isostatic structures (frames and beams), of hyperstatic beams of a section and of hyperstatic frames of a bay, solving the equilibrium of the structure and applying, if required, the deformation conditions.
- Obtain intuitively the deformation of the basic structural diagrams and understand its relationship with the laws of stress variation.
- Analyze articulated bar structures in the plane. Determine efforts and displacements of nodes.
- Dimension and check sections subjected to normal stresses, under the hypothesis of elastic and linear behavior of the material.
- Dimension the section of a bar subjected to bending, taking into account the deflection limitation.
- Dimension and check sections subjected to tangential stresses, under the hypothesis of elastic and linear behavior of the material.
- For all cases of dimensioning and checking, identify stress states of any point in the section associated with any direction.

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Hours medium group</td>
<td>9,0</td>
<td>6.00</td>
</tr>
<tr>
<td>Self study</td>
<td>90,0</td>
<td>60.00</td>
</tr>
<tr>
<td>Hours small group</td>
<td>21,0</td>
<td>14.00</td>
</tr>
<tr>
<td>Hours large group</td>
<td>30,0</td>
<td>20.00</td>
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</tbody>
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Total learning time: 150 h
CONTENTS

C1: STRUCTURAL ANALYSIS

Description:
In this content we work:
Introduction to the calculation and structural design of building structures. Idealization or structural scheme, safety and os
requirements, load hypotheses, safety coefficients, load path, interaction between structural elements.
Corbel structures of bars orthogonal to space: Stress and deformation analysis
Bars and isostatic structures in the plane: Stress and deformation analysis.
Hyperstatic bars of a single section and hyperstatic frames of a bay and a height: Stress and deformed analysis.

Related activities:
Activities 1, 2 and activity 4 corresponding to the practical resolution with directed learning will be carried out and, where
appropriate, their individual continuous and final assessment test.

Full-or-part-time: 60h
Theory classes: 12h
Practical classes: 12h
Guided activities: 4h
Self study : 32h

C2: RESISTANCE OF MATERIALS

Description:
In this content we work:
Normal stresses: Pure axial force. Pure, symmetrical and asymmetrical flex. Symmetric and asymmetric compound bending
Tangential stresses: Pure shear stress. Symmetrical simple bending.
Bending deformations: Twists and elastic or deformed line. Mohr's theorems and / or conjugate beam method. Arrow limitation.

Related activities:
There will be carried out the activity 3 and the activity 4 corresponding to the practical resolution with directed learning and its
continous and final evaluation individual exams.

Full-or-part-time: 90h
Theory classes: 18h
Practical classes: 18h
Guided activities: 4h
Self study : 50h
### A1 PROBLEMS OR ACTIVITY REPORTS - STRUCTURAL ANALYSIS (CONTENT 1)

**Description:**
The students, in groups of 4 or 5 members, will analyze, pose and solve problems or develop activities in which the application of basic concept knowledge is required to achieve the specific objectives of each topic. The works (problems and reports) will be carried out individually and in groups and later they will be corrected by the teachers of the subject.

In the sessions between deliveries of the problems or of the activity reports by the student, the teachers will work on the most significant aspects of the contents of the program to guarantee that the learning objectives are achieved. The active and individual participation of the student will be requested and their attendance, participation and work attitude will be considered.

**Specific objectives:**

**Specific objectives**

At the end of the activity the student will be able to:
- Know the calculation procedure and structural design and understand the concept of idealization of the structure, hypothesis of loads, safety coefficients and transmission and descent of loads.
- Analyze corbel structures of bars orthogonal to space and identify their structural behavior from the law of stress variation.
- Analyze flat structures of bars, basic models, one-section beams and one-bay frames, isostatic and hyperstatic.
- State the equilibrium and deformation conditions and determine the reactions.
- Determine and draw the stress variation law.
- Intuitively draw the deformation of the structures, compare it with the resultant of the stress variation law and adapt your scheme to this result.
- Analyze and compare different types of structures, identifying the modification of the stress variation law and the behavior variation in case of different types of nodes, loads, spans ...
- Get an intuitive knowledge of the structural behavior of basic structures in the plane.

**Generic objectives**

Effective oral and written communication: In the presentation of the group activity, it is necessary that the students present orally among themselves and prepare the presentation of the individual intervention to the classroom. The activity must include a brief memory of the process.

Teamwork: In the course of the activity, each student will carry out the work as a member of the group and one of the parts that make up the activity will also act as responsible directing its approach and development.

Autonomous learning: Apply the knowledge by carrying out the entrusted activity, decide the necessary time included to expand it, including personal contributions and incorporating the sources of documentation.

**Material:**
Presentations of the content differentiated by topic and self-assessment exercises, both test and development, available to ATENEA.

Statements of the problems, which include a brief description of the objectives to be achieved and the methodology to develop them.

**Delivery:**
They will be released on the predetermined date. Each member of the group will be responsible for the direction of a part of the activity.

Return, with return, with the corresponding feedback from the teaching staff and general analysis in a subsequent session, identifying and specifying those learning objectives that must be reinforced.

It represents a part of the continuous evaluation (15%).

**Full-or-part-time:** 43h

Practical classes: 12h
Guided activities: 4h
Self study: 27h
A2 INDIVIDUAL TEST OF CONTINUOUS EVALUATION: STRUCTURAL ANALYSIS (CONTENT 1).

Description:
Individual resolution in the classroom of 2 to 4 questions and/or problems of content 1, analysis and understanding of structural analysis and behavior

Specific objectives:
- Apply the structural design and calculation procedure
- Analyze corbel structures of bars orthogonal to space and identify their structural behavior from the law of stress variation.
- Analyze flat structures of bars, basic models, beams of a section and frames of a bay, isostatic and hyperstatics.
- State the equilibrium and deformation conditions and determine the reactions.
- Determine and draw the stress variation law
- Intuitively draw the deformation of the structures, compare it with the resultant of the stress variation law and adapt your scheme to this result.
- Analyze and compare different types of structures, identifying the modification of the stress variation law and the behavior variation in case of different types of nodes, loads, spans ...
- Formulate intuitive knowledge of the structural behavior of basic structures in the plan.

Material:
Presentation of the topics and the supplementary documentation, basically at class, school library and ATENEA.
The studied problems block which configure the activity 1.
Wordings of the questions and/or problems with their scale included, and a calculator, for the fulfilment of the practice.

Delivery:
Resolution of the activity by the student.
The professor will return it corrected in the next session, according to criteria provided during the course of the activity 1.
It represents a part of the continuous evaluation (30%).

Full-or-part-time: 8h
Practical classes: 3h
Self study: 5h
**A3 PROBLEMS OR ACTIVITY REPORTS - STRENGTH OF MATERIALS (CONTENT 2)**

**Description:**
The students, in groups of 4 or 5 members, will analyze, pose and solve problems or develop activities in which the application of basic knowledge is required to achieve the specific objectives of content 1, the analysis and understanding of behavior structural of basic structures of bars in the plane, isostatic and hyperstatic. The works (problems and reports) will be carried out individually and in groups and later they will be corrected by the teachers of the subject.

In the sessions between deliveries of the problems or of the activity reports by the student, the teachers will work on the most significant aspects of the contents of the program to guarantee that the learning objectives are achieved. The active and individual participation of the student will be requested and their attendance, participation and work attitude will be considered.

**Specific objectives:**

Specific objectives

At the end of the practice, the student or student must be able to:
- Dimension and check sections subjected to normal stresses, under the hypothesis of elastic and linear behavior of the material.
- Dimension the section of a bar subjected to bending, taking into account the deflection limitation.
- Dimension and check sections subjected to tangential stresses, under the hypothesis of elastic and linear behavior of the material.
- For all cases of dimensioning and checking, identify stress states of any point in the section associated with any direction.

Specific objectives

- Effective oral and written communication (In the presentation of the activity in the group, it is necessary for the students to present it orally among themselves and prepare the presentation of it by individual intervention in the classroom. The activity must include a short memory of process)
- Teamwork (In the course of the activity, each student will carry out work as a group member and one of the parts that make up this activity will also act as responsible, directing the approach and development of the same)
- Autonomous Learning. (Apply knowledge by carrying out the entrusted activity, decide the time necessary to expand it, including personal contributions by expanding the most appropriate sources of information)

**Material:**

Presentations of the contents differentiated by topics and self-assessment exercises both test type and development type available in ATENEA.

Problems wordings, which include a brief description of the objectives to be achieved and the methodology to develop them.

**Delivery:**

The problems will be personally delivered in the fixed date. Each member of the group will be responsible of the direction of an equivalent part, having influence in the evaluation of all the group.

Return, with the corresponding feedback of the faculty and general analysis in a following session, identifying and specifying those learning objectives which must be reinforced.

It represents a part of the continous evaluation (15%).

**Full-or-part-time:** 47h
Practical classes: 4h
Self study: 43h
A4 FINAL EXAM

Description:
Individual exam at class of 4 to 10 questions and/or problems related with the learning objectives which can require theoretical
basic plans, as well as the use of teaching material utilised for the subject. (3 hours).
Correction by the faculty.

Specific objectives:
Upon completion of the test, the student should be able to:
· Dimension and check sections of isostatic or hyperstatic bars subjected to states of normal and / or tangential stress, under the
  hypothesis of elastic and linear behavior of the material.
· Dimension the section of a bar subjected to bending, taking into account the deflection limitation.
· Formulate the strain energy.
Calculate the plastic resistant moment of a basic section

Material:
Wording with scales, calculator and if it is necessary the corresponding tables/diagrams.

Delivery:
Resolution of the exam. It represents the 40% of the final mark of the subject.
The correction could be revised in the official fixed date.

Full-or-part-time: 10h
Practical classes: 3h
Self study: 7h

GRADING SYSTEM

There are:
(i) Two groups of Problem deliveries and/or Activity Reports (Pia1; Pia2) worked individually and/or in work groups of 4 or 5 students
(ii) Two Individual Written Tests, a Partial Test (Pp), and a Final Test (Pf)
(iii) The evaluation or final mark, Nf, includes the qualification of all the Problems and/or Activity Reports and the written tests.
(iv) For NR, suspended with a minimum evaluation of 3.5 points out of 10 points, the student may opt for an individual Reassessment
test, NR. The content of this test includes the syllabus of the completed course.

The evaluation system is as follows:
(i) Problems and/or Activity Reports, Pia = (Pia1 + Pia2) (30%).
  Of this 30%, 50% refers to documentary content and the other 50% to student attendance and participation.
(ii) Written tests, Pp = Pp (30%) and Pf = Pf (40%)
(iii) Final note, NF = Pr + Pe+ Pf
(iv) Revaluation note, NR, will replace the NF if NR>NF

The dates scheduled for the delivery and/or completion of each activity are:

A1, Free of Problems and/or Activity Reports 1, Pia1, in three partial deliveries,
  1.1 week 2
  1.2 week 4
  1.3 week 6

A2, Carrying out the partial test, Pp, week 8

A3, Free of Problems and/or Activity Reports 2, Pia2, in three partial deliveries,
  3.1 week 10
  3.2 week 12
  3.3 week 14

A4, Realization of the final test, Pf, according to the EPSEB calendar
EXAMINATION RULES.

If any of the continuous evaluation activities is not carried out, it will be considered as not scored and therefore a 0 will be assigned. The student who does not take the final test will be graded with a not presented (NP).

Only suspended students with a minimum final grade of 3.5 will have access to the Reassessment Test.

BIBLIOGRAPHY

Basic:

Complementary: