Course guide
310709 - 310709 - Introduction to Structures

Last modified: 08/07/2024

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: 2024 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: EDUARDO GALEOTE MORENO

Others: JAVIER FALGUERA VALVERDE
EDUARDO GALEOTE MORENO

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 intertia 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 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 hours per week of practice in the classroom (medium groups / total 30 hours).
- 6 hours per week of autonomous work of the 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 based on:
(i) Expository and participatory classes in large group – avoiding, as far as possible, the expository method of lectures.
(ii) Execution of activities that allow achieving and deepening into 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-.
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 plan. Determine efforts and displacements of nodes.
· Dimension and check sections subjected to normal stresses, under the hypothesis of elastic and linear behaviour 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 behaviour 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

Type	Hours	Percentage
Hours small group	21,0	14.00
Self study	90,0	60.00
Hours medium group	9,0	6.00
Hours large group	30,0	20.00

Total learning time: 150 h

CONTENTS

CONTENT 1: STRUCTURAL ANALYSIS

Description:
In this content we work:
Introduction to the calculation and structural design of building structures. Idealization or structural scheme, safety and use 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 individual mid-semester test.

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

CONTENT 2: RESISTANCE OF MATERIALS

Description:
In this content we work:
Introduction. Definitions: Bar, section, slice. Hypothesis. Balance. Analysis of the section.
Normal stresses: Pure axial force. Pure, symmetrical and asymmetrical flexure. Symmetric and asymmetric compound flexure.
Tangential stresses: Pure shear stress. Symmetrical simple flexure.
Bending deformations: Twists and elastic or deformed lines. Mohr's theorems and/or conjugate beam method. Arrow limitation.

Related activities:
Activities 3 and 4 and individual mid-semester test.

Full-or-part-time: 90h
Theory classes: 18h
Practical classes: 18h
Guided activities: 4h
Self study : 50h

ACTIVITIES

A1 PROBLEMS - STRUCTURAL ANALYSIS (CONTENT 1)

Description:
The students, individually, will analyze, formulate, and solve a problem requiring the application of basic concept knowledge to achieve the specific objectives of each topic. This activity will be carried out individually and later corrected by the course instructors.

This activity consists of 1 session (P1), with a weight of 10 % on the subject grade.

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 behaviour 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 behaviour variation in case of different types of nodes, loads, spans ...
. Get an intuitive knowledge of the structural behaviour of basic structures in the plane.

Material:
Presentations of the content differentiated by topic and self-assessment exercises, both test and development, available at ATENEA.
Statements of the problems, which include a brief description of the objectives to be achieved and the methodology to develop them.

Delivery:
The activities will be carried out individually in the classroom, and their grade and correction will be handed to the students afterwards. After the completion of the in-class test, time will be dedicated to its resolution in the same session, addressing doubts and demonstrating the resolution procedure.

Full-or-part-time: 43h
Self study: 27h
Guided activities: 4h
Practical classes: 12h

A2 EXAM - MID-SEMESTER (CONTENT A).

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 behaviour 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 behaviour variation in case of different types of nodes, loads, spans ...
. Formulate intuitive knowledge of the structural behaviour 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 part 1.
Questions and/or problems with their scale included, and a calculator, for the fulfilment of the task.

Delivery:
Resolution of the activity by the student.
The professor will return it corrected in the next session, according to the criteria provided during the development of activity 1.
It represents a part of the continuous evaluation (40%).

Full-or-part-time: 8h
Self study: 5h
Practical classes: 3h

A3 PROBLEMS - STRENGTH OF MATERIALS (CONTENT B)

Description:
The students, individually, will analyze, formulate, and solve a problem requiring the application of basic concept knowledge to achieve the specific objectives of each topic. This activity will be carried out individually and later corrected by the course instructors.

This activity consists of 1 session (P2), with a weight of 10% on the subject grade.

Specific objectives:
At the end of the practice, the student must be able to:
· Dimension and check sections subjected to normal stresses, under the hypothesis of elastic and linear behaviour 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 behaviour of the material.
· For all cases of dimensioning and checking, identify stress states of any point in the section associated with any direction.

Material:
Presentations of the contents diferentiated by topics and self-assessment exercises both test type and development type avaible in ATENEA.
Problems wordings, which include a brief description of the objectives to be achieved and the methodology to develop them.

Delivery:
The activities will be carried out individually in the classroom, and their grade and correction will be handed to the students afterwards. After the completion of the in-class test, time will be dedicated to its resolution in the same session, addressing doubts and demonstrating the resolution procedure.

Full-or-part-time: 47h
Self study: 43h
Practical classes: 4h

A4 FINAL EXAM (CONTENT B)

Description:
Individual exam at class of 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 behaviour 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
Self study: 7h
Practical classes: 3h

GRADING SYSTEM

There are:
(i) Four individual activities, two per each part of the two blocks (Part A:P1, P2; Part B: P3, P4)
(ii) Two Individual Written Tests, a Partial Test (E_A), and a Final Test (E_B)
(iii) The evaluation or final mark, Nf, includes the qualification of all the Activities 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) Activities, two per each block. Each activity weighs 7,5% over the final mark.
(ii) Written tests, E_A (35%) i E_B (35%)
(iii) Final note, NF = 0.075*P1 + 0.075*P2 + 0.35*E_A + 0.075*P3 + 0.075*P4 + 0.35*E_B
(iv) Revaluation note, NR, will replace the NF if NR>NF. NR will be a maximum of 5 points.

EXAMINATION RULES.

If any of the activities of the continuous evaluation 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 students with a minimum final grade over 3.5 will have access to the Reassessment Test.

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- Dalmau, M. R.; Vilardell, J. Análisis plástico de estructuras : introducción [on line]. Barcelona: Edicions UPC, 2003 [Consultation: 02/10/2014]. Available on: http://ebooks.upc.edu/product/anlisis-plstico-de-estructuras-introduccin. ISBN 9788483019894.