Universidad Zaragoza

Academic Year/course: 2023/24

28612 - Structures I: Introduction to Structures

Syllabus Information

Academic year: 2023/24
Subject: 28612 - Structures I: Introduction to Structures
Faculty / School: 175 - Escuela Universitaria Politécnica de La Almunia
Degree: 422 - Bachelor's Degree in Building Engineering
ECTS: 6.0
Year: 2
Semester: First semester
Subject type: Compulsory
Module:

1. General information

1. General Information

The subject of ***Structures I: Introduction to Structures*** is the first contact that students have in the degree with the subject of structures. It provides essential training for future professional performance as professionals in the construction sector. This subject provides the foundations of structural knowledge that will give the necessary skills to design the best possible structures from regulatory, physical-mechanical, technological, environmental and economiccriteria.

These approaches and goals are aligned with the Sustainable Development Goals (SDGs) of the 2030 Agenda of United Nations (https://www.un.org/sustainabledevelopment/es/), specifically with Goals 4 and 9, so that the acquisition of the learning results of the subject provides training and competence to contribute to some extent to their achievement.

2. Learning results

1. Explain the theory of deformable bodies. Capturing the physical phenomenon of the deformation of solids, as well as the resistance schemes attached to the different structural typologies.
2. Correctly determine the two basic principles that every deformable solid must comply with: Equilibrium of both external forces and internal forces and Compatibility of deformations of the solid with external and internalconstraints.
3. Formulate for simple structural elements, the equations in which both basic principles are reflected.
4. Explain how sectional features affect the overall structural behavior and analysis.
5. Explain the structural strength performance for subsequent sizing.
6. Organize, plan and solve a simple strength of materials and/or structural problem.
7. Determine stresses and strains in pure, compound and simple bending.
8. Solve isostatic and hyperstatic structures.
9. Know how to use the general methodology and software tools at the appropriate level to work with structural systems.
10. To know and apply the fundamentals of Structural Safety Theory based on regulations and instructions construction standards in force.
11. Pre-dimensioning of steel, reinforced and prestressed concrete structures.

3. Syllabus

PART I

Unit 1: Introduction. Fundamental concepts.

Introduction - Purpose of Strength of Materials and Structural Design / Stress and Deformation / Basic Structural Forms . The Beam /Fundamental Hypotheses /Types of Loads / Types of Supports and Bonds /Relationship between applied loads and support reactions / Stresses: concept /Relationship between loads and stresses /Isostatic and hyperstatic structures/ Actions in Structures - Hypotheses of Loads - Combination of actions / Introduction to the Theory of Structural Safety

Unit 2: Isostatic stress calculation.

Laws of Stresses / Introduction to hyperstatic structures / Decomposition of structures into elements / Principle of

Superposition and Symmetry

Unit3: Mechanical properties of materials.

Introduction to the elastic body / Hooke's Law / Principle of Superposition / Generalization of Hooke's Law / Experimental study: stress-strain relationship / Structural safety: limit stress, allowable stress and safety factor / Equivalent stress and failure criteria

Unit 4: Simple tension and compression. Extension bar systems.

Introduction / Axial force in a prismatic piece / Composite cross-sections: various materials / Non-mechanical deformations / Deformation energy and work of external forces / Articulated structures / Isostatic Articulated Structures / Hyperstatic Articulated Structures

Unit 5: Pure Flexion

Previous Concepts: Static Moment, CDG, Centroid, Inertia, Principal Inertia, Inertia Product / Introduction / Pure Straight Bending / PF in mid-plane parts / PF with respect to a principal plane of inertia / Maximum Allowable Moments and Stresses / Elastic modulus of resistance / Geometric shape and yield / Strain energy: Bending / Flexure Pure bending / PF bending: main axes / PF bending: deformation / Mixed beams: composite section / Non-mechanicaldeformations

Unit 6: Compound Bending.

Introduction / Compound Straight Bending / Compound Deflected Bending / Compound Deflected Bending: principal axes / Composite Beams Mixed: composite cross-section / Central core / Temperature deformation: non-linear variation

Unit 7: Simple bending. Shear forces.

Simple bending / Shear stress / Elemental shear stress / Collignon's shear stress / Tangential stresses in sections mass sections (Rectangular, Symmetrical, Circular, Triangular) / Shear stresses in thin-walled sections (Double T-section, C-section) / Closed sections / Shear deformation (Reduced shear area) / Deviatoric shear stress / Mixed sections / Deformation energy Double section, C-section) / Shear strain / Mixed sections / Deformation energy

Unit 8: Pure torsion.

Introduction / Coulomb Theory (Circular Cylinder, Hollow Circular Cylinder, Mixed Sections) / Saint-Venant Theory (Rectangular Section, Open Section)/ Strain energy / Analepsis: center of shear stresses **PART II**

Unit 9: Deformation in beams.

Introduction / Eq. Deformation differential (elastic equation) / Conjugate beam theorem / Navier-Bresse formulas / Mohr's theorems / Symmetry and Antisymmetry (Symmetric load, Antisymmetric load) / Elastic equations of straight bars / Imposed movements and deformations

Unit 10: Energetic Theorems.

Introduction / Work and Energy / Deformation energy and complementary energy / Virtual Work (Unity Force Method) / Castigliano's Theorem

Unit 11: Introduction to hyperstatic structures

Introduction / Compatibility method / Equilibrium method / Example of both methods

Unit 12: Hyperstatic Structures: Compatibility Method

Introduction / Simple Hyperstatic Beams (Bi-supported: Horizontal load, Supported-Embedded, Inclined Bi-supported, Embedded-Supported with Temperature, Bracket with cable, Bracket with inclined cable, Bracket supported on pier, Continuous Beams (Example Continuous Beam, Continuous Beam with Temperature, Continuous Beam Continuous Beam with Support Lowering, Three Moment Equation) / Porches / Arches / Self-Balancing Structures Topic 13: Hyperstatic Structures: Equilibrium Method (Stiffness)

Introduction / Introduction to Matrix Calculus / Cross Method

Unit 14: Buckling

Introduction to buckling / Stability / Euler's critical load / Influence of support conditions / Application of Euler's formula / Mechanical slenderness: Profile Orientation / Buckling Calculation according to structural standards

Unit 15: Articulated Structures

General / Articulated isostatic structures. Stress calculation / Articulated structures. Displacement calculation / Hyperstatic hinged structures

PRACTICAL CONTENTS

Each topic presented in the previous section, has associated practices, either by means of practical assumptions in class or in the laboratory of structures-computer room, interpretation and commentary of readings associated to the subject and/or works leading to obtain results and their analysis and interpretation.

As the topics are developed, these internships will be proposed, and the follow-up will be done through the Moodle platform.

4. Academic activities

- Participative master classes.
- Practical classes with problem solving and case studies.
- Laboratory and structural and/or related software practices.
- Visits to construction sites and facilities of interest for the subject.
- Lectures, seminars and technical conferences.
- Assessment Tests.

This should include:

- Study and personal work.
- Tutorials and generic non face-to-face activities.

5. Assessment system

There are two evaluation systems: continuous assessment and global assessment.

Continuous assessment

It will consist of:

- Midterm exams. 80%
- Practical sessions. 20%

The subject is divided into two parts. Part I of the subject will be assessed by 1 or 2 tests, and Part II will be assessed by 1 test. Part I will account for 60% of the percentage of the Midterm exam and Part II for the remaining 40%.

In order to pass the subject it will be necessary to obtain a minimum score of >40% in each of the parts of the subject (I and II) and that the average obtained between the two parts of the subject is 50%

During the subject there will be a series of practices that will be of obligatory and correct realization by the students in this modality of assessment. Failure to do so or late delivery will result in not being able to continue in this assessment system.

It will be an indispensable condition to pass the subject by continuous assessment to attend/perform 100% of the classroom activities: classroom exercises, technical visits, practicals, seminars, structural software courses, etc

Provided that all continuous assessment practices have been completed, portions will be kept during the academic year.

Overall assessment

The student must opt for this modality when, due to his/her personal situation, he/she cannot adapt to the pace of work required in the continuous assessment system, or has not passed the subject in the continuous assessment.

The global assessment test will consist of a written exam in which there will be theoretical, theoretical-practical questions and problems. This test will account for 100% of the grade for the subject, and students must obtain more than 50% to pass it.

In the case of students who have followed the continuous assessment but have not passed the subject (or any of the two parts of the course) by this modality, the global assessment test will represent 80% and the practices carried out in the continuous assessment will represent 20%. Likewise, they must obtain >50% in the global assessment test in order to be able to mediate.