SUBJECT TEACHING GUIDE

G1978 - Calculus for Structural Analysis

Degree in Civil Engineering
First Degree in Civil Engineering

Academic year 2024-2025

1. IDENTIFYING DATA					
Degree	Degree in Civil Engineering First Degree in Civil Engineering			Type and Year	Compulsory. Year 3 Compulsory. Year 3
Faculty	School of civil Engineering				
Discipline	ANALYSIS AND TECHNOLOGY OF STRUCTURES				
Course unit title and code	G1978 - Calculus for Structural Analysis				
Number of ECTS credits allocated	6	Term		Semester based (2)	
Web					
Language of instruction	Spanish	English Friendly	No	Mode of delivery	Face-to-face

Department	DPTO. INGENIERIA ESTRUCTURAL Y MECANICA
Name of lecturer	RAFAEL DIEZ ALMAGRO
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Other lecturers	JOSE RAMON IBAÑEZ DEL RIO

3.1 LEARNING OUTCOMES

--Understands structural reality and the models and calculation methods that idealize it.

- Understands the reality of the loads that act on a structure and their correct consideration in structural models and programs.

- Understands conventional and matrix methods for calculating structures, and their adaptation to calculation programs.

- Knows the typology and understands the resistant behavior of the most common structural types (articulated and flat reticulated structures), having the capacity for analysis.

-Critically analyzes the results of a calculation and uses them practically in the sizing of real structures.

-Use structural calculation programs and know the theory that underlies them. Assume the principles of uncertainty and risk in the calculation of structures.

4. OBJECTIVES

- Acquire knowledge of structural reality and its idealization through appropriate structural models.

- Understand the reality of the actions that a structure supports and their adequate consideration in the corresponding model.

- Learn to calculate a structure using the conventional flexibility method and its practical application to the study of lattices of any type.

- Understand the concept of instability of elements under compression loads and apply it in the design of trusses.

- Learn to calculate a structure using the conventional stiffness method and its practical application in the calculation of continuous beams and frames of any type.

- Learn the concept of line of influence in order to apply it in the study of structures under the action of moving loads, particularly in the calculation of bridges.

- Learn the general technique of matrix calculation of structures using the rigidity matrix method and its practical application to the most common structural types: lattices, trusses and grilles.

- Know the characteristics of commercial structural calculation programs and their practical use in the calculation of some simple examples.

6. SUBJECT PROGRAM	
CONTENTS	
1	1. INTRODUCTION TO STRUCTURE CALCULATION 1.1. Concepts of structure and structural model, and differences between both. Types of structural elements and its idealization for calculation. Structural models: structures composed of 1-D, 2-D and 3-D elements. Characteristics of real loads and actions, and their idealization. Types of requests. Relationships used in the calculation of structures: equilibrium equations, compatibility and constitutive. Analysis methods. Structures composed of 1-D elements: hypotheses and simplifications.
2	2. CALCULATION OF STRUCTURES BY THE METHOD BALANCE 2.1. Structures composed of 1-D elements. Concepts of isostatism and hyperstatism. Unknowns basics of the method. Balance matrix concept. Application to the calculation of isostatic plane lattices. Characteristics of real lattices and their idealization. Effort calculation. 2.2. Concept of kinematic matrix: calculation of movements. 23. Alternative method for calculating movements: unit force theorem. 2.4. Characteristics of kinematic type actions: thermal actions, seats and assembly defects. 2.5. Particular case of canonical lattices.
3	3. CALCULATION OF STRUCTURES BY THE METHOD FLEXIBILITY 3.1. Basic characteristics and unknowns of the method. Flexibility matrix concept. Application to calculus of continuous beams: three moment theorem. 3.2. Application to the calculation of hyperstatic lattices. Determination of the degree of hyperstatism. Calculation of efforts and movements. 3.3. Kinematic type actions. Generalization of unit force theorem.
4	4. GEOMETRICLY NOT STRUCTURES LINEAR 4.1. Introduction to the study of the buckling phenomenon. Characteristics of slender elements subjected to axial compression forces. Ideal elements: hypotheses and simplifications. 4.2. Critical Euler charge: concept and calculation. Concept of equivalent buckling length. Mechanical slenderness and Euler hyperbola. 4.3. Characteristics of the real elements and their difference with Euler's theory: buckling load. 4.4. Practical application: buckling calculation of bars of a lattice in accordance with the Eurocode.

5	Organization Blocks 5. CALCULATION OF STRUCTURES BY THE METHOD OF RIGIDITY 5.1. Basic characteristics and unknowns of the method. Stiffness matrix concept. Application to the analysis of flat frameworks. 5.2. Concepts of intraslationality and translationality. Direct calculation of intra-translational frameworks using the stiffness matrix method: obtaining movements and efforts. 5.3. Effect of kinematic actions: seats and thermal actions. 5.4. Continuous beams as a particular case of intra-translational frameworks.
6	6. APPLICATION OF THE RIGIDITY METHOD TO ANALYSIS OF TRANSLATIONAL FRAMEWORKS 6.1. Translational frameworks: concept of degree of translationality and practical determination. 6.2. Indirect calculation of translational frameworks: obtaining efforts and movements. 6.3. Kinematic actions: thermal actions and seating. 6.4. Direct matrix method of stiffness matrix: degrees of freedom technique.
7	7. EFFECT OF MOBILE LOADS ON THE CALCULATION OF STRUCTURES: LINES OF INFLUENCE AND ENVELOPES. 7.1. Concepts of influence line and envelope. 7.2. Maxwell's theorem: application to the calculus of lines of influence on isostatic structures. 7.3. Calculation of influence lines in structures hyperstatic. Particular case of continuous beams. 7.4. Envelopes of terrible requests due to freight trains and overloads. 7.5. Practical applications in the sizing of structures: bridges, industrial warehouses, buildings, etc.
8	8. MATRIX CALCULATION OF STRUCTURES: RIGIDITY MATRIX METHOD 8.1. Local stiffness matrices of 1-D elements: lattices, frameworks, grilles. 8.2. Local stiffness matrices of 2-D elements: introduction to the finite element method. 8.3. Transformation matrices and matrix assembly overall stiffness of a structure. Introduction of the boundary conditions. Concordant supports and not concordant. 8.4. Calculation of movements and efforts. 8.5. Characteristics and use of the programs computer commercials based on the method of stiffness matrix. Practical applications.

7. ASSESSMENT METHODS AND CRITERIA

Description	Type	Final Eval.	Reassessn	%
Evaluation 1 The exam will consist of 2-3 practical or theoretical-practical exercises corresponding to blocks 1 to 4.	Written exam	No	Yes	30,00
Description Evaluation 2	Written exam	Yes	Yes	40,00
Description Practices	Work	No	No	20,00
Description Laboratory tests	Laboratory evaluation	No	No	10,00
TOTAL				100,00

Observations

For the presentation of each of the exams, it is mandatory for students to submit the computer and laboratory practices established at the beginning of the course.
In relation to the agreements adopted in the ordinary session of the School Board held on June 10, 2010, it is established that, with respect to the activities of evaluation that have the character of recoverable,
• As a general criterion and unless something is specified in this guide different, a student may only appear for the recovery of those activities that you have not passed, that is, in which you have not obtained a minimum rating of five out of ten.
• As a general criterion and unless something is specified in this guide differently, in the recovery period the evaluation procedure of a activity will be the same as that of the activity that originates it.
Note: According to royal decree RD 1125/2003 on the European credit system and the grading system in official university degrees and validity throughout the national territory, the results obtained by the student in Each of the subjects in the curriculum will be graded based on the following numerical scale from 0 to 10, with a decimal expression, to which you can add its corresponding qualitative qualification:
0,0-4,9: Suspenso (SS).
5,0-6,9: Aprobado (AP).
7,0-8,9: Notable (NT).
9,0-10: Sobresaliente (SB).

Only for duly justified reasons (e.g. health restrictions) can evaluation tests be organized remotely, with prior authorization from the Center Management.

Observations for part-time students

Students enrolled part-time may take the entire subject in the final exam, with the same requirements demanded of the rest of the students in said exam.

8. BIBLIOGRAPHY AND TEACHING MATERIALS
BASIC
CÁLCULO DE ESTRUCTURAS. José Ramón González de Cangas y Avelino Samartín Quiroga. Ed. Colegio de Ingenieros de Caminos, Canales y Puertos (1999). ISBN-84-380-0155-6
CÁLCULO MATRICIAL DE ESTRUCTURAS. Avelino Samartín Quiroga y José Ramón González de Cangas. Ed. Colegio de Ingenieros de Caminos, Canales y Puertos (2001). ISBN-84-380-0179-3