SUBJECT TEACHING GUIDE

G1450 - Structural Analysis

Degree in Civil Engineering
BILINGUAL UC-CU CIVIL ENGINEERING PROGRAM

Academic year 2023-2024

1. IDENTIFYING DATA				
Degree	Degree in Civil Engineering BILINGUAL UC-CU CIVIL ENGINEERING PROGRAM		Type and Year	Compulsory. Year 2 Optional. Year 1
Faculty	School of civil Engineering			
Discipline	ANALYSIS AND TECHNOLOGY OF STRUCTURES Optional Subjects			
Course unit title and code	G1450 - Structural Analysis			
Number of ECTS credits allocated	6	Term	Semester based (2)	
Web				
Language of instruction	English		Mode of delivery	Face-to-face

Department	DPTO. INGENIERIA ESTRUCTURAL Y MECANICA
Name of lecturer	ALBERTO FERNANDEZ LEROY
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Other lecturers	RAFAEL DIEZ ALMAGRO

3.1 LEARNING OUTCOMES

- 1. Comprehension of the structural reality and the models and calculation methods that idealised it.
2. Comprehension of real loads acting on a structure and their proper consideration in the structural models and computer programs.
3. Comprehension of conventional and matrix methods of structural analysis and their adaptation to the existing computer programs.
4. Comprehension of the resistant behaviour of the most common structural typologies and development of the capability for calculating them.
5. Capability for the critical analysis of the calculation results and their practical application for dimensioning real structures.
6. Capability for using some existing computer programs of structural analysis and knowledge of the theory they are based on.

4. OBJECTIVES

-To acquire the knowledge of the structural reality and its idealisation by means of proper structural models .
-To learn the reality of loads acting on a structure and their proper consideration in the corresponding structural model .
-To learn how to calculate a structure by using the conventional flexibility method and its practical application to the analysis of plane-trusses.
-To understand the concept of structural instability of elements under compressive loads and its application to the design of plane-trusses.
-To learn how to calculate a structure by means of the conventional stiffness method and its application to the analysis of any kind of continuous beams and plane frames.
-To learn the concept of influence line in order to apply it to the analysis of structures under mobile loads , in particular bridge-decks calculation.
-To learn the general stiffness-matrix method of structural analysis and its practical applications: plane trusses, plane frames and plane grids.
-To know the features of some existing computer programs and their practical use in several simple examples .

6. COURSE ORGANIZATION	
	CONTENTS
1	1. INTRODUCTION TO THE STRUCTURAL CALCULATION 1.1. Concepts of structure and structural model. Types of structural elements. Structures composed of 1-D, 2-D and 3-D elements. Characteristics of real loads and their idealisation. Basic relationships in structural analysis: equilibrium, compatibility and constitutive. Methods of analysis. Structures composed of 1-D elements: hypotheses and simplifications.
2	2. STRUCTURAL CALCULATION BY MEANS OF THE EQUILIBRIUM METHOD 2.1. Structures composed of 1-D elements. Statically determinate and indeterminate structures. Basic unknowns. Concept of equilibrium matrix. Application to the analysis of statically determinate plane-trusses. Real plane-trusses and their idealisation. Calculation of axial-forces. 2.2. Concept of kinematic matrix. calculation of displacements. 2.3. Alternative method for the calculation of displacements; theorem of unit-force. 2.4. Kinematic actions: thermal effects, settlements and construction faults. 2.5. Canonical plane-trusses as a specific case.
3	3. STRUCTURAL CALCULATION BY MEANS OF THE FLEXIBILITY METHOD 3.1. Characteristics and basic unknowns of the method. Concept of flexibility matrix. Application to the analysis of continuous-beams: three-moment theorem. 3.2. Application to the analysis of statically-indeterminate plane-trusses. Degree of indeterminacy. Calculation of axial-forces and displacements. 3.3 Kinematic actions. Generalisation of the unit-force theorem.
4	4. GEOMETRIC NON-LINEAR STRUCTURES 4.1. Introduction to the study of buckling. Characteristics of slender elements subjected to compressive forces. Ideal elements: hypotheses and simplifications. 4.2. Euler´s critical load: concept and calculation. Concept of equivalent buckling length. Mechanical slenderness and Euler´s hyperbola. 4.3. Characteristics of real elements and their differences from Euler´s theory : buckling load. 4.4. Practical application: buckling loads in plane-truss elements according to the Eurocodes.
5	5. STRUCTURAL CALCULATION BY MEANS OF THE STIFFNESS METHOD 5.1. Characteristics and basic unknowns of the method. Concept of stiffness matrix. Application to the analysis of plane frames. 5.2. Translational and non-translational structures. Direct calculation of non-translational plane frames by stiffness-matrix method: displacements and forces. 5.3. Kinematic actions: settlements and thermal effects. 5.4. Continuous-beams as a specific case of non-translational plane frames.
6	6. APPLICATION OF THE STIFFNESS METHOD TO THE ANALYSIS OF TRANSLATIONAL PLANE FRAMES 6.1. Translational plane frames: Concept of degree of translation and its practical obtention. 6.2. Indirect calculation of translational plane frames: displacements and forces. 6.3. Kinematic actions: thermal effects and settlements. 6.4. Direct stiffness-matrix method: degree-of-freedom technique.
7	7. THE EFFECT OF MOBILE LOADS IN STRUCTURAL ANALYSIS: INFLUENCE LINES 7.1. Concept of influence line. 7.2. Maxwell´s theorem: Application to the calculation of influence lines in statically determinate structures. 7.3. Calculation of influence lines in statically indeterminate structures: Continuous beams as a specific case. 7.4. Most unfavourable effects due to real actions: concentrated and uniformly distributed loads. 7.5. Practical applications: Bridges, industrial facilities, buildings, etc.

8	8. STRUCTURAL MATRIX ANALYSIS: GENERAL STIFFNESS-MATRIX METHOD 8.1. Local stiffness matrix of 1-D elements: plane truss, plane frame and plane grid. 8.2. Local stiffness matrix of 2-D elements: introduction to the finite element method. 8.3. Transformation matrix. Assembly of the global stiffness matrix of a structure. Introduction of boundary conditions. Concordant and non-concordant supports. 8.4. Calculation of displacements and forces. 8.5. Characteristics and practical use of some existing computer programs based upon the stiffness matrix theory .

7. ASSESSMENT METHODS AND CRITERIA

Description	Type	Final Eval.	Reassessn	%
Every two weeks there will be a test of 30 minutes dealing with the theory explained so far.	Work	No	No	10,00
There will be 2 partial exams corresponding to blocks 1 to 4, the first one, and blocks 5 to 8 the second. Each of these exams consist of two practical or theoretical-practical problems.	Written exam	No	No	30,00
This exam is aimed at the students who have failed any of the four problems corresponding to the partial exams so that they can retake them.	Written exam	No	Yes	60,00
TOTAL				100,00

Observations
As a general criterion and unless otherwise specified in this guide, a student can only apply for the recovery of those activities that have not passed, that is, in which he has not obtained a minimum score of five out of ten.

Observations for part-time students
Students enrolled part-time can be examined for the entire subject in the final exam, with the same requirements as the rest of the students in said exam.

8. BIBLIOGRAPHY AND TEACHING MATERIALS

BASIC

STRUCTURAL ANALYSIS. Aslam Kassimali. Ed. Cengage Learning. ISBN 978-0-495-29565-5