Course guide
2500026 - GECCONSMET - Steel Structures

Last modified: 01/10/2023

Unit in charge: Barcelona School of Civil Engineering
Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering.

Degree: BACHELOR'S DEGREE IN CIVIL ENGINEERING (Syllabus 2020). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan, English

LECTURER

Coordinating lecturer: ROLANDO ANTONIO CHACÓN FLORES

Others: ROLANDO ANTONIO CHACÓN FLORES, SERGIO GALLEGO URBANO, ENRIQUE MIRAMBELL ARRIZABALAGA

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
14401. Ability to analyze and understand how the characteristics of structures influence their behavior. Ability to apply knowledge about the resistant operation of structures to size them according to existing regulations and using analytical and numerical calculation methods. (Common module to the Civil branch)
14403. Knowledge of the fundamentals of the behavior of reinforced concrete structures and metal structures and ability to conceive, design, build and maintain these types of structures. (Common module to the Civil branch)

Generical:
14380. Scientific-technical training for the exercise of the profession of Technical Engineer of Public Works and knowledge of the functions of advice, analysis, design, calculation, project, construction, maintenance, conservation and exploitation.
14383. Ability to project, inspect and direct works, in their field.
14390. Identify, formulate and solve engineering problems. Pose and solve construction engineering problems with initiative, decision-making skills and creativity. Develop a systematic and creative method of analysis and problem solving. (Additional school competition).
14391. Conceive, project, manage and maintain systems in the field of construction engineering. Cover the entire life cycle of an infrastructure or system or service in the field of construction engineering. (Additional school competition).

TEACHING METHODOLOGY

The course consists of 2 hours per week of classroom activity (large size group) and 2 hours weekly with half the students (medium size group).

The 2 hours in the large size groups are devoted to theoretical lectures, in which the teacher presents the basic concepts and topics of the subject, shows examples and solves exercises.

The 2 hours in the medium size groups is devoted to solving practical problems with greater interaction with the students. The objective of these practical exercises is to consolidate the general and specific learning objectives.

Support material in the form of a detailed teaching plan is provided using the virtual campus ATENEA: content, program of learning and assessment activities conducted and literature.

The course consists of 4 hours per week of master sessions during 15 weeks (60 hours total). The course is divided in Lectures (approximately 33 hours), problem-solving sessions (16 hours), Laboratory (5 hours) and practice tests and exams (6 hours).

The lectures are focused on the most relevant aspects of the course. Due to time constraints, other topics must be addressed by the student with the help of the given references, personal notes and additional documentation provided.

The course is completely managed throughout the Virtual Campus ATENEA. Content, Exams, Activities as well as References are given in ATENEA at the beginning of the course.

Although most of the sessions will be given in the language indicated, sessions supported by other occasional guest experts may be held in other languages.

LEARNING OBJECTIVES OF THE SUBJECT

Producer of steel for the manufacture of profiles and plates used in construction, thus with the typical structural types in metal construction. Calculation bases. Limit states, actions, durability and materials. Stress-strain behavior of metal structures facing sectional forces such as axial forces, shear forces, bending and torsion moments, taking in account the possible interaction between the behavior of the elements in front of phenomena of instability: basic equations and design equations (flexural buckling and lateral buckling). Screwed joints and welted joints in steel structures.

1 Ability to define actions and combinations of actions to consider in the steel structures project. Capacity to design and/or check the strength of the sections against different types of forces and their interaction.
2. Ability to design and/or check the structural elements of concrete or metal against buckling phenomena.
3 Ability to design usual steel structural types.

Knowledge of the fundamentals of the behavior of steel structures and ability to conceive, project, build and maintain this type of structures. Knowledge of the production of steel for the manufacture of profiles and plates, as well as common structural types in metal construction. Knowledge of the stress-strain behavior of steel structures against sectional forces, axial forces, shear forces, bending moments and torsion moments, taking into account their possible interaction, and of the behavior of the elements against instability phenomena: basic equations and deisgning equations (flexural buckling and lateral buckling). Knowledge of the behavior of bolted joints and welded joints in metal structures.

STUDY LOAD

Type	Hours	Percentage
Hours large group	30,0	20.00
Hours medium group	24,0	16.00
Hours small group	6,0	4.00
Guided activities	6,0	4.00
Self study	84,0	56.00

Total learning time: 150 h

CONTENTS

Topic 1. Introduction to steel structures

Description:
Introduction to steel structures

Full-or-part-time: 2h 24m
Theory classes: 1h
Self study : 1h 24m

Topic 2: The steel material

Description:
2.1 Characteristics of steels 2.2 Types of steel 2.3 Steel products 2.4 Handbooks: ProfileCelsa 2.5 Steel production 2.6 Failure criteria
Exercises

Full-or-part-time: 7h 11m
Theory classes: 2h
Practical classes: 1h
Self study : 4h 11m

Topic 3: Project bases

Description:
3.1 Generalities. 3.2 The limit state method: Last limit states and service limit states. 3.3 Durability-oriented calculation bases. 3.4 Actions. Combination of actions. 3.5 Steel material. Partial coefficient for resistance.
Exercises

Full-or-part-time: 7h 11m
Theory classes: 2h
Practical classes: 1h
Self study : 4h 11m

Topic 4: Serviceability Limit States. Deflections

Description:
4.1 Deflections limits in buildings 4.2 Deflections limits in bridges
Exercises

Full-or-part-time: 4h 48m
Theory classes: 1h
Practical classes: 1h
Self study : 2h 48m

Topic 5: Ultimate Limit States. Cross-sectional resistance

Description:
5.1 General principles of calculation 5.1.1 Elastic analysis 5.1.2 Characteristics of cross sections 5.1.3 Effects of shear lag 5.2 Classification of cross sections 5.3 Tensile elements 5.4 Compression elements 5.5 Flexural elements 5.6 Shear stress 5.7 Bending-shear interaction 5.8 Bending-axial interaction 5.9 Bending-Axial-Shear interaction
Exercises
Laboratories

Full-or-part-time: 21h 36m
Theory classes: 6h
Practical classes: 2h
Laboratory classes: 1h
Self study : 12h 36m

Topic 6: Sizing of structural elements subjected to bending

Description:
6.1 Global elastic analysis 6.2 Global plastic analysis 6.3 Structural types 6.3.1 Plate girders 6.3.2 Trusses and cantilever beams
Exercises
Laboratories

Full-or-part-time: 19h 12m
Theory classes: 4h
Practical classes: 2h
Laboratory classes: 2h
Self study : 11h 12m

Evaluation

Full-or-part-time: 14h 23m
Laboratory classes: 6h
Self study : 8h 23m

Topic 7: Structural elements subjected to torsion loads

Description:
7.1 General 7.2 Uniform torsion 7.3 Warping 7.4 Mixed torsion 7.5 Sizing of elements subjected to torsion 7.6 Shear-torsion interaction 7.7 Bending-torsion interaction
Exercises
Laboratories

Full-or-part-time: 16h 48m
Theory classes: 4h
Practical classes: 2h
Laboratory classes: 1h
Self study : 9h 48m

Topic 8: Ultimate limit state of instability. Bucklings

Description:
8.1 Ideal columns. Critical load. Equilibrium bifurcation 8.2 Real columns. Equilibrium divergence 8.3 European buckling curves 8.4 Sizing of compressed elements 8.5 Sizing of compressed elements for different buckling lengths 8.5.1 Canonical elements 8.5.2 Frames 8.5.3 Triangulated structures 8.5.4 Elements subjected to variable axial force. 8.5.5 Flexural torsional buckling and torsion and torsional buckling 8.6 Lateral Torsional Buckling 8.6.1 Ideal part. Critical moment of LTB 8.6.2 Sizing of elements subjected to bending in front of LTB 8.7 Sizing of elements subjected to compression and bending. 8.7.1 Simplified method 8.7.2 General method
Exercises
Laboratories

Full-or-part-time: 33h 36m
Theory classes: 9h
Practical classes: 4h
Laboratory classes: 1h
Self study : 19h 36m

Topic 9: Connections

Description:
10.1 Introduction 10.1.1 General considerations 10.1.2 Determination of stresses in the joints and distribution between the elements of the joint 10.1.3 Classification of the joints subjected to bending moment. Moment-rotation diagram. 10.2 Bolted joints 10.2.1 Types of bolts 10.2.2 Categories of bolted joints 10.2.3 Constructive provisions 10.2.4 Prestressed bolts 10.2.5 Strength of bolted joints 10.2.6 Distribution of forces between bolts 10.2.7 Types of bolted joints. Calculation 10.3 Welded joints 10.3.1 General 10.3.2 Types of joints and cords 10.3.3 Constructive arrangements for angled cords and butt cords 10.3.4 Strength of angled cords and butt cords 10.3.5 Casting of stresses between the cords of a joint 10.3.6 Types of welded joints. Calculation
Exercises
Laboratories

Full-or-part-time: 16h 48m
Theory classes: 4h
Practical classes: 2h
Laboratory classes: 1h
Self study : 9h 48m

GRADING SYSTEM

A series of two exams (A1, A2) will be performed throughout the course. In addition, the students must develop 6 hours of guided activities (AD). All evaluations contribute to the final marks.The final marks consist of the contributing part from the exams and the contributing part of the guided activities.

On the one hand, the exams are based upon theoretical questions concerning important concepts that arise throughout the course and upon exercises in which these concepts are applied. The exams include all the worked material up to date. On the other hand, the guided activities are based upon case-studies in which both practical and theoretical concepts of the design of steel structures are involved.

The exams are weighted in the following fashion: A = 0,50*A1 +0,50*A2

The final mark of the course (NF) is obtained as follows: NF = 0,75*A +0,25 *AD

Criteria for re-evaluation qualification and eligibility: Students that failed the ordinary evaluation and have regularly attended all evaluation tests will have the opportunity of carrying out a re-evaluation test during the period specified in the academic calendar. Students who have already passed the test or were qualified as non-attending will not be admitted to the re-evaluation test. The maximum mark for the re-evaluation exam will be five over ten (5.0). The non-attendance of a student to the re-evaluation test, in the date specified will not grant access to further re-evaluation tests. Students unable to attend any of the continuous assessment tests due to certifiable force majeure will be ensured extraordinary evaluation periods.

These tests must be authorized by the corresponding Head of Studies, at the request of the professor responsible for the course, and will be carried out within the corresponding academic period.

EXAMINATION RULES.

If any of the laboratory or continuous assessment activities are not performed in the scheduled period, it will be considered a zero score.

BIBLIOGRAPHY

Basic:

- Espanya. Comisión Permanente de Estructuras de Acero. EAE : instrucción de acero estructural: con comentarios de los miembros de la Comisión Permanente de Estructuras de Acero [on line]. Madrid: Ministerio de Fomento. Secretaría General Técnica, 2011 [Consultation: 08/02/2021]. Available on: https://www.mitma.es/recursos_mfom/1903100.pdf. ISBN 9788449809040.
- Trahair, N.; Nethercot, D.; Gardner, L. The behaviour and design of steel structures to EC3. 4th ed. London ; New York: Taylor & Francis, 2008. ISBN 9780415418669.
- Simoes da Silva, L.; Simoes, R.; Gervásio, H. Eurocode 3 : design of steel structures. : Part 1-1: General rules and rules for buildings. Brussels: European Convention for Constructional Steelwork, 2010. ISBN 9783433029732.