Course guide
320054 - ECI - Structures and Industrial Construction

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 737 - RMEE - Department of Strength of Materials and Structural Engineering.
Degree: BACHELOR’S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Compulsory subject).
Academic year: 2022   ECTS Credits: 9.0   Languages: Catalan, Spanish

LECTURER

Coordinating lecturer: Ernest Bernat Masó
Others:

PRIOR SKILLS

Knowledge about Strength of materials and elasticity

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. MEC: Knowledge and capability for design and calculation of structures and industrial buildings.

TEACHING METHODOLOGY

The subject is organized in the following way:
- Theory sessions, where theoretical concepts will be developed. They will be carried out in class using expositive method. Blackboard and digital presentations will be also used.
- Practical sessions, where theoretical concepts will be applied in order to solve practical examples. They will be carried out in reduced groups in comparison with theory sessions.
- Activities, where different aspects are dealt. They are done individually or in group and at classroom or at home.
LEARNING OBJECTIVES OF THE SUBJECT

The subject has two parts that are combined along the course:

First part: calculation of structures:
- Representing structures by using the common symbols and identifying the boundary conditions and load configurations
- Typing the analytical formulation of the internal efforts distribution (axial, shear and bending) along the structure
- Calculating the movements (displacements and rotations) at any point of a framework using the energetic theorems (Castigliano) and the formulation by Navier-Bresse
- Calculating the reactions at the supports of externally hyperstatic frameworks using the force method and the displacement method
- Calculating structures using direct stiffness method.

Second part: industrial construction:
- Listing and describing the different steps in the construction process of an industrial building and the job positions that an engineer can develop in this process.
- Designing the structure of an industrial building. Identifying and describing the most common typologies of framed structures and their component elements.
- Sizing and/or checking the stress level of the structural elements of an industrial building (steel structures) accordingly with the current standard. Using the plasticity hypothesis and taking into account the instability processes.
- Analysing and interpreting the documentation which is commonly used for sizing the structural elements (codes, catalogues,)

STUDY LOAD

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<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Hours large group</td>
<td>60.0</td>
<td>26.67</td>
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<tr>
<td>Hours medium group</td>
<td>30.0</td>
<td>13.33</td>
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<tr>
<td>Self study</td>
<td>135.0</td>
<td>60.00</td>
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Total learning time: 225 h

CONTENTS

Module 01: Previous knowledge

Description:
a) Review of elasticity and strength of materials.
b) Review of geometric characteristics of flat sections.
c) Review of calculation of tensions in flat sections.
d) Review of calculation of laws of efforts and movements.

Full-or-part-time: 9h
Theory classes: 1h
Practical classes: 3h
Self study: 5h

Module 02: Design and execution of an industrial building

Description:
a) Steps of the industrial buildings constructive process.
b) Engineers in construction
c) Standards and construction codes

Full-or-part-time: 7h
Theory classes: 2h
Self study: 5h
Module 03: Urban planning

Description:
 a) Territory organisation
 b) Urban codes

Full-or-part-time: 8h
 Theory classes: 2h
 Practical classes: 1h
 Self study: 5h

Module 04: Typology of an industrial building.

Description:
 a) Vocabulary and terminology.
 b) Structural functions.
 c) Typologies of frames.
 d) Metal profile.

Full-or-part-time: 7h
 Theory classes: 2h
 Self study: 5h

Module 05: Introduction to metallic structures.

Description:
 a) Metal structures: advantages and disadvantages
 b) Phases of construction.
 c) The material: steel.

Full-or-part-time: 12h
 Theory classes: 4h
 Self study: 8h

Module 06: Projection and calculation of steel structures.

Description:
 a) General.
 b) Project bases: execution classes
 c) Limit State Design
 d) Loads

Related activities:

Full-or-part-time: 19h
 Theory classes: 4h
 Practical classes: 3h
 Self study: 12h
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<thead>
<tr>
<th>Module 07: Deformation calculations</th>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
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<tr>
<td>a) Navier formulation</td>
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<td>b) Theorems of Castigliano.</td>
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<td><strong>Full-or-part-time:</strong> 25h</td>
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<td>Theory classes: 7h</td>
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<td>Practical classes: 6h</td>
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<td>Self study : 12h</td>
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<tr>
<th>Module 08: Hyperstatic restraints reaction calculation</th>
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<tr>
<td><strong>Description:</strong></td>
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<tr>
<td>a) Basis of methodologies.</td>
</tr>
<tr>
<td>b) Calculation of one-dimensional hyperstatic structures using the compatibility method.</td>
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<tr>
<td>d) Calculation of two-dimensional hyperstatic structures using the compatibility method.</td>
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<tr>
<td>c) Calculation of one-dimensional hyperstatic structures using the equilibrium method.</td>
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<tr>
<td>e) Calculation of two-dimensional hyperstatic structures using the equilibrium method.</td>
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<td><strong>Related activities:</strong></td>
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<td><strong>Full-or-part-time:</strong> 26h</td>
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<td>Theory classes: 10h</td>
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<td>Practical classes: 4h</td>
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<td>Self study : 12h</td>
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<th>Module 09: Serviceability Limit State (SLS)</th>
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<td><strong>Description:</strong></td>
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<tr>
<td>a) Bases.</td>
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<td>b) Vertical deformation.</td>
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<td>c) Horizontal deformations.</td>
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<td><strong>Full-or-part-time:</strong> 7h</td>
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<td>Practical classes: 2h</td>
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<td>Self study : 5h</td>
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<tr>
<td><strong>Description:</strong></td>
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<tr>
<td>a) Concept of plastic hinge.</td>
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<td>b) Buckling and dent.</td>
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<tr>
<td>c) Classification of sections</td>
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<td>d) Strength of sections</td>
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<td><strong>Full-or-part-time:</strong> 35h</td>
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<tr>
<td>Theory classes: 10h</td>
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<td>Practical classes: 4h</td>
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<td>Self study : 21h</td>
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### Module 11: Instability of prismatic pieces

**Description:**
- a) Concept of buckling length.
- b) Real parts.
- d) Methodology.

**Full-or-part-time:** 14h  
Theory classes: 4h  
Self study : 10h

### Module 12: Structural design and checking

**Description:**
- a) Integrating ELS and ELU checking  
- b) Comparing elastic and plastic design  
- c) Influence of buckling in design

**Full-or-part-time:** 21h  
Theory classes: 2h  
Practical classes: 3h  
Self study : 16h

### Module 13: Direct stiffness method

**Description:**
- a) Stiffness matrix  
- b) Connectivity  
- c) Global boundary conditions  
- d) Local boundary conditions  
- e) Other boundary conditions (elastic, thermal)  
- f) Internal hinges

**Full-or-part-time:** 30h  
Theory classes: 10h  
Practical classes: 4h  
Self study : 16h

### Module 14: Precast concrete structures

**Description:**
- a) Description of precast concrete structures  
- b) Precasting systems  
- c) Assessment of precast system

**Full-or-part-time:** 5h  
Theory classes: 2h  
Self study : 3h
GRADING SYSTEM

Students’ knowledge acquisition is assessed as follows:
- First examination (N.E.1): 25%
- Second examination (N.E.2): 35%
- Resolution of Problems at classroom (N.P.): 20%
- Home activities (N.A.C.): 20%
- Final qualification (N.F.):

\[
N.F. = 0.25 \times N.E.1 + 0.35 \times N.E.2 + 0.20 \times N.P. + 0.20 \times N.A.C.
\]

For those students who meet the requirements and submit to the reevaluation examination, the grade of the reevaluation exam will replace the grades of all the on-site written evaluation acts (tests, midterm and final exams) and the grades obtained during the course for lab practices, works, projects and presentations will be kept.
If the final grade after reevaluation is lower than 5.0, it will replace the initial one only if it is higher. If the final grade after reevaluation is greater or equal to 5.0, the final grade of the subject will be pass 5.0.

EXAMINATION RULES.
- Depending on the case, lecturer-directed activities will be carried out in a group or individually.
- Lecturer-directed activities developed in class should be carried out in the specified time.
- Lecturer-directed activities developed outside class should be delivered at time specified in the wording.

BIBLIOGRAPHY

Basic:

Complementary:

RESOURCES

Other resources:
Profile Celsa is a program that provides access and management of a chart of hot rolled steel profiles supplied by CELSA-Compañía Española de Laminación, S.L.
http://www.celsa.com/Productos.mvc/PerfilesComercial?=Prontuario />
The Computer Program of Metallic and Mixed Structures is a freely distributed tool for the analysis, calculation and design of metallic and mixed structures.
https://goo.gl/Fvktuh />
The Structural Steel Instruction (EAE) aims to establish the requirements to be met by structural steel structures related to structural
safety, fire safety and environmental protection, and to provide a procedure to comply with them, which affects Design, implementation and control of steel structures; All with the ultimate aim, within the framework of the structural reliability laid down in the structural Eurocodes, to ensure adequate safety.

https://goo.gl/cZlu0y

The Basic Document (DB) is designed to establish rules and procedures to meet the basic requirements of structural security.