250708 - Non-Linear Analysis of Steel Structures

Coordinating unit: 250 - ETSECCPB - Barcelona School of Civil Engineering
Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering
Academic year: 2019
Degree: MASTER’S DEGREE IN STRUCTURAL AND CONSTRUCTION ENGINEERING (Syllabus 2015). (Teaching unit Optional)
ECTS credits: 5  Teaching languages: Catalan, Spanish, English

Teaching staff

Coordinator: ESTHER REAL SALADRIGAS
Others: ROLANDO ANTONIO CHACÓN FLORES, ENRIQUE MIRAMBELL ARRIZABALAGA, ESTHER REAL SALADRIGAS

Degree competences to which the subject contributes

Specific:
13364. To conceive and design civil and building structures that are safe, durable, functional and integrated into its surroundings.
13365. Designing and building using traditional materials (reinforced concrete, prestressed concrete, structural steel, masonry, wood) and new materials (composites, stainless steel, aluminum, shape memory alloys?).
13366. To evaluate, maintain, repair and strengthen existing structures, including the historic and artistic heritage.

13369. To apply methods and advanced design software and structural calculations, based on knowledge and understanding of forces and their application to the structural types of civil engineering.

General:
13360. To conceive, design, analyze and manage structures or structural elements of civil engineering or building, encouraging innovation and the advance of knowledge.
13361. To develop, improve and use conventional materials and new construction techniques to ensure the safety requirements, functionality, durability and sustainability.
13362. To define construction processes and methods of organization and management of projects and works.

Teaching methodology

The course consists of 2.3 hours per week of classroom activity (large size group) and 0.3 hours weekly with half the students (medium size group).

The 2.3 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 0.3 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.

The rest of weekly hours devoted to laboratory practice.

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.

Learning objectives of the subject
250708 - Non-Linear Analysis of Steel Structures

Subject to deepen the nonlinear phenomena and their effects in steel structures

Capability to recognize and understand the tough and tense - deformatonal mechanisms of steel structures in nonlinear behavior. Ability to evaluate the influence of these mechanisms in their design and calculation


<table>
<thead>
<tr>
<th>Study load</th>
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<tbody>
<tr>
<td><strong>Total learning time:</strong> 125h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Theory classes:</td>
<td>19h 30m</td>
<td>15.60%</td>
</tr>
<tr>
<td>Practical classes:</td>
<td>9h 45m</td>
<td>7.80%</td>
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<tr>
<td>Laboratory classes:</td>
<td>9h 45m</td>
<td>7.80%</td>
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<tr>
<td>Guided activities:</td>
<td>6h</td>
<td>4.80%</td>
</tr>
<tr>
<td>Self study:</td>
<td>80h</td>
<td>64.00%</td>
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</table>
### Content

<table>
<thead>
<tr>
<th>Introduction</th>
<th>Learning time: 2h 24m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 1h</td>
<td>Self study : 1h 24m</td>
</tr>
</tbody>
</table>

#### Description:
In this session the principles of nonlinear behavior of steel structures are presented.

<table>
<thead>
<tr>
<th>Geometric nonlinearity</th>
<th>Learning time: 7h 11m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 2h</td>
<td>Practical classes: 1h</td>
</tr>
<tr>
<td>Self study : 4h 11m</td>
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</tbody>
</table>

#### Description:
Description of the basic principles of the effects of geometric nonlinearity on steel structures.
Introduce a software for instability check in steel elements.

<table>
<thead>
<tr>
<th>Structural analysis</th>
<th>Learning time: 21h 36m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 5h</td>
<td>Laboratory classes: 4h</td>
</tr>
<tr>
<td>Self study : 12h 36m</td>
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</table>

#### Description:
This session will define the criteria for determining whether a frame should be classified as sway or non-sway, and the equivalent imperfections to be used for analysis in second order.
In this session, the different methods of analysis to be used depending on the degree of sway for the present structure are presented.
In this session the software to be used for solving practical 2 and 3 are presented.

<table>
<thead>
<tr>
<th>Material nonlinearity</th>
<th>Learning time: 7h 11m</th>
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<tbody>
<tr>
<td>Theory classes: 3h</td>
<td>Self study : 4h 11m</td>
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</tbody>
</table>

#### Description:
In this session elastoplastic methods and overall plastic nonlinear analysis of steel structures are presented.
# Introduction to seismic analysis of steel structures

**Description:**
In this session the basic principles of seismic analysis in steel structures are presented.

**Learning time:** 7h 11m  
Theory classes: 3h  
Self study: 4h 11m

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# Algorithms for solution of nonlinear problems

**Description:**
This session is a brief introduction to the operation of different algorithms for solving nonlinear problems.

**Learning time:** 7h 11m  
Theory classes: 3h  
Self study: 4h 11m

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# Plate buckling

**Description:**
The basic principles of plate buckling are introduced and special mention to the phenomenon of shear buckling and patch loading is done.

**Learning time:** 7h 11m  
Theory classes: 3h  
Self study: 4h 11m

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# Joints

**Description:**
We present the differences between the frames design with rigid and semi-rigid joints. Some computer programs to analyze frames with semi-rigid joints are presented. Example for design of a frame with semi-rigid joints using a software.

**Learning time:** 14h 23m  
Theory classes: 2h  
Practical classes: 4h  
Self study: 8h 23m
Advanced methods

**Description:**
In this session some advanced analysis methods that are being developed in various research fields are presented.

<table>
<thead>
<tr>
<th>Learning time: 4h 48m</th>
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<tbody>
<tr>
<td>Theory classes: 2h</td>
</tr>
<tr>
<td>Self study : 2h 48m</td>
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</table>

Final Exercise

**Description:**
this session is for working on the different final course work developed by the students

<table>
<thead>
<tr>
<th>Learning time: 14h 23m</th>
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<tbody>
<tr>
<td>Practical classes: 3h</td>
</tr>
<tr>
<td>Laboratory classes: 3h</td>
</tr>
<tr>
<td>Self study : 8h 23m</td>
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Qualification system

The mark of the course is obtained from the ratings of continuous assessment and their corresponding laboratories and/or classroom computers.

Continuous assessment consist in several activities, both individually and in group, of additive and training characteristics, carried out during the year (both in and out of the classroom).

The teachings of the laboratory grade is the average in such activities.

The evaluation tests consist of a part with questions about concepts associated with the learning objectives of the course with regard to knowledge or understanding, and a part with a set of application exercises.

Regulations for carrying out activities

Failure to perform a laboratory or continuous assessment activity in the scheduled period will result in a mark of zero in that activity.
Bibliography

Basic:


