310021 - Structures II

Coordinating unit: 310 - EPSEB - Barcelona School of Building Construction
Teaching unit: 753 - TA - Department of Architectural Technology
Academic year: 2017
Degree: BACHELOR'S DEGREE IN ARCHITECTURAL TECHNOLOGY AND BUILDING CONSTRUCTION (Syllabus 2015). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN BUILDING CONSTRUCTION SCIENCE AND TECHNOLOGY (Syllabus 2009). (Teaching unit Compulsory)
ECTS credits: 6 Teaching languages: Catalan, Spanish

Teaching staff

Coordinator: Sanabra, Marc
Others: Sanabra, Marc
Palmero, Maria Fabiana
Vilanova, Josep
Lorente, Sandokán

Opening hours

Timetable: Marc Sanabra: friday from 11 to 12h
Fabiana Palmero: friday from 11 to 12h
Josep Vilanova: thursday from 15 to 16h
Sandokán Lorente: thursday from 11 to 12h; and friday from 11 to 12h

Prior skills

The students must be capable of:
Identify the type of load that is present in a section of a bar and calculate his value, according to the loads and links of the bar.
Formulate the laws of tension and deformations in a section, according to the load that is present.
Calculate resistant capacity to compression, traction, flexion, cutting and torsion of a section, under the hipotesi of an elastic and lineal performance of the material.
Calculate the maximum deflection of a bar subjected to bending.
Describe the differences between the resistant plastic moment and the resistant elastic moment of a section.

Requirements

It is recommended to have passed the subjects of Mechanics and Structures I

Degree competences to which the subject contributes

Specific:
1. FE-15 Aptitude for the pre-measuring, design, calculation and verification of structures and manage its materials execution.

Transversal:
2. EFFECTIVE USE OF INFORMATION RESOURCES - Level 3. Planning and using the information necessary for an academic assignment (a final thesis, for example) based on a critical appraisal of the information resources used.
3. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.
310021 - Structures II

Teaching methodology

The guided learning consists in:
- Expositives classes - with participation (big group):
The teacher does a brief exposition to introduce the general goals of learning related to the basic concepts of the subject and explains the theoretical content. With practical exercises we try to motivate and involucrate the students to actively participate in their learning.

Teaching material is used to help in a detailed docent plan, through ATENEA: goals of learning by content, concepts, examples, programation of evaluation activities and guided learning and bibliography.

In general, after each class, exercises are proposed to be done outside of class, that must be done individually or in group.
- Workshop (medium group):
The students resolve the exercises. The teacher answers the doubts of the students.
- Laboratory (big group):
The students, guided by the teacher assists to tests about real specimens in the laboratory, and compare the results with the ones that are obtained analitically.
- Guided acticity (work outside of class):
The students solve exercises and prepare an inform related to the observed tests in the laboratory. The generated documentation is delivered through Atenea, to be evaluated.

The time of learning outside of class consists in:
- Reading of the bibliography.
- Study of the theoretical concepts.
- Resolution of the exercises that complement the study of theoretical concepts.
- Resolution of the exercises proposed in the workshop.

Learning objectives of the subject

At the end of the course, students should be able to:
- Differentiate between a 1st and a 2nd order analyses.
- Explain the ultimate state method.
- Calculate the ultimate response of a rolled steel section to any applied load.
- Pre-design and verify the design of rolled steel members subjected to any applied load.
- Design and verify beam-column connections and connections at column bases in rolled steel structures.
- Calculate the ultimate response of a reinforced concrete section subjected to any load.
- Calculate the instantaneous, long-term and active deflections in reinforced concrete members subjected to bending.
- Verify the design of reinforced concrete bars subjected to any load.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group: 45h</th>
<th>30.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours medium group:</td>
<td>15h</td>
<td>10.00%</td>
</tr>
<tr>
<td>Hours small group:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td>Guided activities:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td>Self study:</td>
<td>90h</td>
<td>60.00%</td>
</tr>
</tbody>
</table>
## Content

### C1 INTRODUCTION TO STRUCTURAL SECURITY; PLASTICITY IN STRUCTURES MADE OF LINEAR ELEMENTS; INTRODUCTION TO STEEL STRUCTURES

<table>
<thead>
<tr>
<th>Description:</th>
<th>Learning time: 23h 07m</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1. Ultimate Limit State: definition, description, steel structures case, reinforced concrete case.</td>
<td>Theory classes: 7h 16m</td>
</tr>
<tr>
<td>1.2. Serviceability Limit State: definition, description, steel structures case, reinforced concrete case.</td>
<td>Practical classes: 2h</td>
</tr>
<tr>
<td>1.3. Geometric properties of cross sections, both in elastic regime as in plastic regime.</td>
<td>Self study : 13h 51m</td>
</tr>
<tr>
<td>1.4. Stresses in cross sections, both in elastic regime as in plastic regime.</td>
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<tr>
<td>1.5. Plasticity in linear elements.</td>
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</tr>
<tr>
<td>1.6. Nomination of the steel classes and description of their basic mechanical features</td>
<td></td>
</tr>
<tr>
<td>1.7. Partial security coefficients and design strength.</td>
<td></td>
</tr>
<tr>
<td>1.8. Sorts of profiles depending on their manufacturing process.</td>
<td></td>
</tr>
</tbody>
</table>

**Related activities:**
Activities A1, A2, A3 and A5 will be done, which correspond to a laboratory practice, one individual continuous evaluation exercise, the midterm exam and the final exam, respectively.

### C2 STEEL STRUCTURES: INTRODUCTION TO BUCKLING AND CHECK OF STEEL LINEAR ELEMENTS

<table>
<thead>
<tr>
<th>Description:</th>
<th>Learning time: 37h 40m</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1. Introduction to buckling (elastic instability).</td>
<td>Theory classes: 10h 54m</td>
</tr>
<tr>
<td>2.2. Classes of steel cross sections. Concept of efficient cross section for class 4.</td>
<td>Practical classes: 4h</td>
</tr>
<tr>
<td>2.3. Strength of steel cross sections after CTE Code.</td>
<td>Guided activities: 2h</td>
</tr>
<tr>
<td>2.4. Check of compressed linear elements: Buckling due to pure axial force.</td>
<td>Self study : 20h 46m</td>
</tr>
<tr>
<td>2.5. Check of flexured linear elements: Buckling due to flexure moment (torque buckling).</td>
<td></td>
</tr>
<tr>
<td>2.6. Check of linear elements under compression and flexure.</td>
<td></td>
</tr>
<tr>
<td>2.7. Check of a steel column under axial force and two flexure moments.</td>
<td></td>
</tr>
</tbody>
</table>

**Related activities:**
Activities A1, A2, A3 and A5 will be done, which correspond to the laboratory practice, one continuous evaluation exercise, the midterm exam and the final exam, respectively.
### C3 Steel Structures: Junctions

**Description:**
- 3.1. Junction types depending on their stiffness and strength
- 3.2. Strength of the welded junctions
- 3.3. Strength of bolt junctions
- 3.4. Beam-Column junctions: Design and check

**Related activities:**
Activities A3 and A5 will be done, which correspond to the midterm exam and the final exam, respectively.

### C4 Reinforced Concrete: Analysis Fundamentals. Analysis of Sections and Linear Elements Under Normal Stresses

**Description:**
- 4.1. Name and description of the material features.
- 4.2. Stress-strain diagrams for reinforceent steel.
- 4.3. Stress-strain diagrams of the reinforced concrete.
- 4.4. Resistance calculation of the materials; safety partial coefficients of the materials.
- 4.5. Basic hypothesis; Deformation domain.
- 4.6. Measuring and checking to uniaxial, complex, straight and biaxial bending.
- 4.7. Measuring and checking to simple and compressive stress.
- 4.8. Regulations regarding to the frameworks: Minimum and maximum proportions.

**Related activities:**
Activities A4 and A5 will be done, which correspond to one individual continuous evaluation exercise and the final exam, respectively.
### C5 REINFORCED CONCRETE: SECTIONS AND LINEAR ELEMENTS UNDER SHEAR STRESSES

**Description:**
- 5.1. Forces and stresses in a reinforced concrete linear element under a shear force.
- 5.2. Check of a linear element under a shear force.
- 5.3. Check of a linear element under a torque force.
- 5.4. General criteria for reinforcement design; Minimum steel amounts.

**Related activities:**
Activity A5 will be done, which corresponds to the final exam.

<table>
<thead>
<tr>
<th>Learning time</th>
<th>Theory classes: 3h 14m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Practical classes: 1h</td>
</tr>
<tr>
<td></td>
<td>Self study : 6h 55m</td>
</tr>
</tbody>
</table>

### C6 SERVICEABILITY OF REINFORCED CONCRETE: DEFLECTION

**Description:**
- 6.2. Bended elements.
- 6.3. Minimum depths.
- 6.4. Computation of instant deflection.
- 6.5. Computation of long term deflection.
- 6.6. Computation of total deflection and incremental deflection, and comparison to allowable limits.

**Related activities:**
Activity A5 will be done, which corresponds to the final exam.

<table>
<thead>
<tr>
<th>Learning time</th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Practical classes: 1h</td>
</tr>
<tr>
<td></td>
<td>Self study : 6h 55m</td>
</tr>
</tbody>
</table>

### Qualification system

The final qualification (of the course) is the addition of the following partial qualifications:

\[ N_{\text{final}} = 0.5 \cdot N_f + 0.10 \cdot N_{q1} + 0.10 \cdot N_{q2} + 0.20 \cdot N_p + 0.1 \cdot N_a \]

- \( N_f \): qualification of the final exam.
- \( N_{q1} \): qualification of the first punctuable practice (week 9)
- \( N_{q2} \): qualification of the second punctuable practice (week 14)
- \( N_p \): qualification of the partial exam (determined by EPSEB)
- \( N_a \): qualification of assistance to the laboratory practice and the project delivered in Atenea

The week in that is expected an exam can change if there is a modification in the expected pace of delivery of content.
### Regulations for carrying out activities

If some activity of continued evaluation is not done, will be considered as non evaluated.
The mark of the final exam (NF) does an average with the rest of the marks. Passing the final exam without the average passed is not enough to pass the subject by course.
This subject offers re-evaluation exams for the students that have failed the subject by course.

### Bibliography

#### Basic:


#### Complementary:
