Course guide
250244 - CALESTRUC - Structural Design

Last modified: 22/05/2024

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

Degree: BACHELOR'S DEGREE IN PUBLIC WORKS ENGINEERING (Syllabus 2010). (Optional subject).

Academic year: 2024 **ECTS Credits:** 6.0 **Languages:** Spanish

LECTURER

Coordinating lecturer: LUIS MIGUEL CERVERA RUIZ - JOAN BAIGES AZNAR

Others: JOAN BAIGES AZNAR, LUIS MIGUEL CERVERA RUIZ, JOSE MANUEL GONZALEZ LOPEZ

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
3079. Knowledge of the different types and basis for calculating prefabricated items and its application to the manufacturing processes
3080. Knowledge of the design, calculation, construction and maintenance of building works in regard to their structure, finishes, installations and equipment.
3085. Ability to construct geotechnical works

Generical:
3105. Students will learn to identify, formulate and solve a range of engineering problems. They will be expected to show initiative in interpreting and solving specific civil engineering problems and to demonstrate creativity and decision-making skills. Finally, students will develop creative and systematic strategies for analysing and solving problems.
3106. Students will learn to assess the complexity of the problems examined in the different subject areas, identify the key elements of the problem statement, and select the appropriate strategy for solving it. Once they have chosen a strategy, they will apply it and, if the desired solution is not reached, determine whether modifications are required. Students will use a range of methods and tools to determine whether their solution is correct or, at the very least, appropriate to the problem in question. More generally, students will be encouraged to consider the importance of creativity in science and technology.
3107. Students will learn to identify, model and analyse problems from open situations, consider alternative strategies for solving them, select the most appropriate solution on the basis of reasoned criteria, and consider a range of methods for validating their results. More generally, students will learn to work confidently with complex systems and to identify the interactions between their components.
3111. Students will learn to plan, design, manage and maintain systems suitable for use in civil engineering. They will develop a systematic approach to the complete life-cycle of a civil engineering infrastructure, system or service, which includes drafting and finalising project plans, identifying the basic materials and technologies required, making decisions, managing the different project activities, performing measurements, calculations and assessments, ensuring compliance with specifications, regulations and compulsory standards, evaluating the social and environmental impact of the processes and techniques used, and conducting economic analyses of human and material resources.
3112. Students will develop an understanding of the different functions of engineering, the processes involved in the life-cycle of a construction project, process or service, and the importance of systematising the design process. They will learn to identify and interpret the stages in preparing a product design specification (PDS), draft and optimise specifications and planning documents, and apply a systematic design process to the implementation and operation phases. Students will learn to write progress reports for a design process, use a range of project management tools and prepare final reports, and will be expected to show an awareness of the basic economic concepts associated with the product, process or service in question.
3113. Students will learn to identify user requirements, to draft definitions and specifications of the product, process or service in question, including a product design specification (PDS) document, and to follow industry-standard design management models. Students will be expected to show advanced knowledge of the steps involved in the design, execution and operation phases and to use the knowledge and tools covered in each subject area to the design and execution of their own projects. Finally, students will assess the impact of national, European and international legislation applicable to engineering projects.

Transversal:
586. ENTREPRENEURSHIP AND INNOVATION - Level 2. Taking initiatives that give rise to opportunities and to new products and solutions, doing so with a vision of process implementation and market understanding, and involving others in projects that have to be carried out.
589. SUSTAINABILITY AND SOCIAL COMMITMENT - Level 2. Applying sustainability criteria and professional codes of conduct in the design and assessment of technological solutions.
594. TEAMWORK - Level 3. Managing and making work groups effective. Resolving possible conflicts, valuing working with others, assessing the effectiveness of a team and presenting the final results.
584. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.

TEACHING METHODOLOGY

The course consists of 4 hours per week of classes during the 15 weeks of the semester.
The approximate distribution of the 60 contact hours is as follows:
36 hours of lectures devoted to the exposition of the concepts and materials of the course.
12 hours of practical sessions devoted to the presentation of examples and exercises and problems.
4 hours laboratory and directed activities devoted to practical exercises to consolidate the objectives of general and specific learning of the subject.
8 hours devoted to assessment.

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

Students will acquire specialised knowledge of structural analysis.

Civil construction pathway

Calculation basis in structural design; Current regulations on actions, calculation and execution; Project conditions for designing and/or testing structures; Ultimate limit states and serviceability limit states; Plate analysis; Approximate plate-analysis methods; Failure methods; Introduction to elasticity; Discretisation of continuous systems: finite element method; 2D and 3D elasticity problems; Pre-process and post-process; Introduction to dynamic and seismic analysis; One-degree-of-freedom systems; Response spectra; Multiple-degree-of-freedom systems; Nonlinear structural calculation; Nonlinear material: theory of plastic moment; Moment diagrams; Geometric non-linearity: Instability

STUDY LOAD

Type	Hours	Percentage
Hours large group	30,0	20.00
Hours medium group	15,0	10.00
Hours small group	15,0	10.00
Guided activities	6,0	4.00
Self study	84,0	56.00

Total learning time: 150 h

CONTENTS

Structural reliability and structural basis of design

Description:
Introduction. Semiprobabilista probabilistic representation and representation. Required reliability. Actions, action effects (surround, lines of influence) and combination of actions. Limit states.
Structural reliability and structural design bases. Problems
Structural reliability and structural design bases. Laboratory

Full-or-part-time: 28h 47m
Theory classes: 6h
Practical classes: 2h
Laboratory classes: 4h
Self study : 16h 47m

Funicular Structures

Description:
Cables. Arcos.
Funicular Structures. Problems

Full-or-part-time: 9h 36m
Theory classes: 2h
Practical classes: 2h
Self study : 5h 36m

Second-order analysis

Description:
Slender columns. Isolated concrete column. Isolated concrete column and steel
Analysis of second order. Problems

Full-or-part-time: 9h 36m
Theory classes: 2h
Practical classes: 2h
Self study : 5h 36m

Plastic Analysis

Description:
Introduction to plastic design. Calculation plastic sections. Elastoplastic behavior of a beam isostatic. General Survey of statically indeterminate systems. Resolution of beams and frames by Theorem maximum and minimum theorem combination of mechanisms.
Plastic calculation. Problems

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

Plates

Description:
Differential Equation of Equilibrium of a plate with the Kirchhoff-Love hypothesis. Boundary Conditions. Navier solution for different types of loads. Evaluation of flat grates. Method of virtual frames by EHE and analysis of plates on point supports. Plates. Problems

Full-or-part-time: 24h
Theory classes: 6h
Practical classes: 4h
Self study : 14h

Shells

Description:
Introduction. General Equations of behavior. Cylindrical shells.
Sheets. Problems

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

Dynamic Analysis

Description:
Introduction. Rigidity. Damping and excitation dynamics. Undamped free vibration-free damped, forced harmonic and transient integral convolution. Seismicity and accelerograms. Equations of dynamic equilibrium of systems of various degrees of freedom. Introduction to matrix analysis.
Dynamic Analysis. Problems
Dynamic Analysis. Laboratory

Full-or-part-time: 33h 36m
Theory classes: 8h
Practical classes: 2h
Laboratory classes: 4h
Self study : 19h 36m

GRADING SYSTEM

The final grade is the weighted average of the one obtained in the periodic evaluation exercises (AV), the exercises carried out in the practical classes and directed activities (AD) and in the final work of the subject (AT).

The periodic evaluation (A) is obtained as: AV = 0.4 * A1 + 0.6 * A2, being A1 and A2 the two periodic evaluations.

The final grade for the subject will be:

Subject grade = 0.3*(AV grade) + 0.3*(AD grade) + 0.6*(AT grade) if each of the AV, AD and AT grades has obtained a grade equal to or greater than 5.0.

Otherwise, the mark of the subject will be: Mark of the subject = 0.3*(Nota AV) + 0.1*(Nota AD) + 0.6*(Nota AT)

To pass , the mark of the course must be equal to or greater than 5.0.

Criteria for qualification and admission to re-evaluation: Students suspended in the ordinary evaluation who have regularly taken the evaluation tests of the failed subject will have the option to take a re-evaluation test in the period established in the academic calendar. The students who have already passed it or the students qualified as not presented will not be able to present themselves to the re-evaluation test of a subject. The maximum grade in the case of taking the reevaluation exam will be five (5.0). The non-attendance of a student summoned to the re-evaluation test, held within the established period, may not give rise to another test with a later date Extraordinary evaluations will be carried out for those students who, due to proven force majeure, have not been able to carry out any of continuous assessment tests. These tests must be authorized by the corresponding head of studies, at the request of the professor responsible for the subject, and will be carried out within the corresponding academic period.

EXAMINATION RULES.

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:
- Cervera, M.; Blanco, E. Mecánica y resistencia de materiales. Barcelona: CIMNE, 2012. ISBN 9788494024399.
- Cervera, M.; Blanco, E. Mecánica de estructuras [on line]. 2a ed. Barcelona: Edicions UPC, 2002 [Consultation: 04/05/2021]. Available on: http://hdl.handle.net/2099.3/36196. ISBN 8483016354.
- Argüelles, R ... [et al.]. Cálculo matricial de estructuras en primer y segundo orden: teoría y problemas. Madrid: Bellisco, 2005. ISBN 8496486125.
- Argüelles, R. Cálculo de estructuras: tomo II. Madrid: Escuela Técnica Superior de Ingenieros de Montes, 1986. ISBN 8460024121.
- Barbat, A; Canet, J.M. Estructuras sometidas a acciones sísmicas : cálculo por ordenador. 2a ed. Barcelona: CIMNE, 1994. ISBN 8487867103.

Complementary:
- Torroja, E. Razón y ser de los tipos estructurales. Madrid: Colegio de Ingenieros de Caminos, Canales y Puertos, 2007. ISBN 9788438003701.
- Muttoni, A. L'art d'estructures . Une introduction au fonctionnement des structures en architecture. 2e ed. Lausanne, Switzerland: Presses Polytechnique et Universitaires Romandes, 2012. ISBN 9782880749804.