Experimental Techniques for the Characterization of Structures and Structural Materials (250713)

General Information

School	ETSECCPB
Departments	Departament d'Enginyeria Civil i Ambiental (DECA)
Credits	5.0 ECTS
Programs	MÀSTER UNIVERSITARI EN ENGINYERIA ESTRUCTURAL I DE LA CONSTRUCCIÓ (pla 2015)
Course	2024/25

Main teaching language at each group

- Group 10ES2 Spanish (Q2)

Faculty

Responsible Faculty: Rolando Antonio Chacón Flores
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Objectives of Education

Course on how to face real-life problems in the field of engineering with regards to the characterization of structures and building materials. It includes training on the basic use and prototyping of sensors, data acquisition systems and graphic user interfaces.

Capability to define the tests to be applied to a structure with damage in their structural evaluation, and define the criteria for monitoring the construction process of a singular structure

Scientific and analytical method. Characterisation of physical properties. Characterization of properties related to durability. Characterization of mechanical properties. Instrumental techniques . Monitoring structures. Preparation of technical documents and presentations

The main objectives of the course are:

Provide a learning experience for the use and development of various experimental techniques for characterizing structures and materials based on sensors, imaging, and point clouds.

Provide a learning experience with diverse materials and structural typologies.

Competencies

Especific

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

Generic

To conceive, design, analyze and manage structures or structural elements of civil engineering or building, encouraging innovation and the advance of knowledge.
To develop, improve and use conventional materials and new construction techniques to ensure the safety requirements, functionality, durability and sustainability.

Total hours of student work

		Hours	Percentage
Supervised Learning	Large group	25.5 h	56.67 %
	Medium group	9.75 h	21.67 %
	Laboratory classes	9.75 h	21.67 %
	Guided Activities	0.0 h	0.00 %
Self Study		80.0 h	

Contents

Block 1

Sensors
Data acquisition systems
Graphical User Interface
These sessions include two development practices

There is also a a practical session of scanning a real scene which is subsequently processed using computational geometry tools.

Specific Objectives

Introduce the use sensors and remote sensing techniques in Construction

Block 2

Experimental techniques for structural concrete
Experimental techniques in steel structures
Experimental techniques for cementitous materials
Experimental techniques in masonry structures
Experimental techniques for bridges

Activities

Development of a digital twin of a simple structural system

Measurement, calibration, and visualization of results from sensors in a simple structural system (beam, mold, portal frame, or similar)

Objectives

Measure and collect precise data from sensors installed in the structural system.
Calibrate the sensors to ensure the accuracy and reliability of the collected data.
Visualize the obtained results in a clear and understandable manner.
Analyze the structural behavior under various loading conditions.
Identify potential weak points or anomalies in the structure.
Propose design improvements based on the collected data.

Material

Sensors, microcontrollers, Software (Rhinoceros + Grasshopper)

Delivery

A report with multimedia files as well as the created physical object

Dedication

6h

Petant-Camins

The Petant-Camins activity involves creating a physical scene of a traditional Mediterranean game in the plaza de camins, specifically pétanque. First, the game setup is created with the balls and necessary elements. Once the scene is ready, it is scanned with a laser scanner to capture all the details. Subsequently, the virtual scene obtained is analyzed using computational geometry tools to study its characteristics and behavior. This activity combines the tradition of the pétanque game with advanced scanning and virtual analysis technology.

Objectives

Recreate a physical scene of the pétanque game in the plaza de camins.
Use a laser scanner to accurately capture the physical scene.
Analyze the obtained virtual scene using computational geometry tools, such as Grasshopper.
Compare the collected data from the physical scene with the virtual scene.
Develop a methodology to integrate traditional games with advanced technologies.
Promote the understanding and appreciation of the pétanque game through the use of technology.

Material

Various balls, da Vinci bridge, laser scanner, software (Grasshopper)

Delivery

A report with key results

Dedication

3h

Teaching Methodology

Different activities are carried out with the aim of improving students' learning and skills in dealing with practical problems. The included activities are divided into two groups, which are explained below.

"Vamos a medir" (Let's Measure): Students learn practically how to use measurement equipment and low-cost sensors to evaluate physical parameters that help determine the state of elements or structures (deflection, displacement, vibration, temperature, humidity, among others). They also learn how to assemble automatic measurement systems that can be easily installed on the structure or elements to evaluate their behavior. A set of sensors and an Arduino board are provided for students to practice and assemble their own system to perform measurements in the laboratory.

Theoretical-Practical Classes: A compendium of information related to different experimental techniques used by different groups in the section is presented. It covers experimental techniques in the fields of metal construction, concrete, building, bridges, and materials. Emphasis is placed on the use of Laser Scanner and computer vision techniques are introduced.

Support material in the form of a detailed teaching plan is provided through the virtual campus ATENEA. It includes content, the program of learning activities, and literature on the topics studied.

Although most sessions will be conducted in the language indicated in the guide, sessions in which there is occasional support from other guest experts may be conducted in another language.

Grading Rules

(*) The evaluation calendar and grading rules will be approved before the start of the course.

The final grade for the subject is obtained from the continuous assessment grades and the corresponding laboratory and/or computer classroom grades.

Continuous assessment involves completing various activities, both individual and group-based, that are additive and formative in nature, carried out throughout the course (inside and outside the classroom).

--- Development of a measuring instrument
--- Presentation of results report
--- Communication and dissemination of the conducted research using posters or videos
--- Final Exam

Test Rules

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

Office Hours

The hours of attention will be Friday morning under appointment. Alternatively, students can schedule meetings by contacting directly with each profesor by e-mail.

Bibliography

Basic

- Suryanarayana, C. Experimental techniques in materials and mechanics [Recurs electrònic]. Boca Raton [etc.]: CRC Press, cop. 2011. ISBN 9781439895238.
- Silyn-Roberts, H. Writing for science and engineering : papers, presentations and reports. 2nd ed. Oxford: Butterworth-Heinemann, 2013. ISBN 9780080982854.
- Organtini, G. Scientific Arduino programming. Roma: Sapienza Università di Roma, 2015.
- Blanco Díaz, Elena; Oller, S; Gil Espert, Lluís. Análisis experimental de estructuras. Barcelona: CIMNE, 2008. ISBN 9788496736474.