

Course guide

250143 - ENGMARPOR - Maritime and Port Engineering

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Unit in charge:	Barcelona School of Civil Engineering	
Teaching unit:	751 - DECA - Department of Civil and Environmental Engineering.	
Degree:	BACHELOR'S DEGREE IN CIVIL ENGINEERING (Syllabus 2010). (Compulsory subject). BACHELOR'S DEGREE IN CIVIL ENGINEERING (Syllabus 2017). (Compulsory subject).	
Academic year: 2023	ECTS Credits: 6.0	Languages: English

LECTURER

Coordinating lecturer:	AGUSTIN SANCHEZ-ARCILLA CONEJO
Others:	VICENTE GRACIA GARCIA, JOSE ANTONIO JIMENEZ QUINTANA, MARIA LISTE MUÑOZ, AGUSTIN SANCHEZ-ARCILLA CONEJO, XAVIER SÁNCHEZ ARTÚS, JUAN PABLO SIERRA PEDRICO

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:

- 3039. Ability to construct and conserve maritime works.
- 3040. Understanding of the climate-wind-waves-coast inter-relation and how this conditions maritime works.

Generical:

- 3104. 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.
- 3110. 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:

585. ENTREPRENEURSHIP AND INNOVATION - Level 1. Showing enterprise, acquiring basic knowledge about organizations and becoming familiar with the tools and techniques for generating ideas and managing organizations that make it possible to solve known problems and create opportunities.

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 classroom activity.

The classroom hours are devoted to theoretical lectures, in which the lecturer presents the basic concepts and topics of the subject, shows examples and solves exercises.

Some time is also 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 time is devoted to laboratory practice and assimilated activities.

Support material in the form of a detailed teaching plan is provided including: contents, program of learning and assessment activities and some references (bibliography) from the state-of-art, in the form of text books or engineering manuals.

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 a basic understanding of maritime engineering and develop skills for the construction and preservation of maritime structures.

Upon completion of the course, students will have acquired the ability to: 1. Carry out a wave analysis using measurements taken by a buoy. 2. Design the basic elements of a port. 3. Carry out a coastal dynamics study that includes port-coast interaction.

The sea, environmental conditions and coastal hydraulics; Regular and irregular wave action; Wave formation, propagation and breaking; Currents and tides; Transport and dispersion; Models; Testing beaches and breakwaters; Planning ports and coasts; Port engineering; Types; Areas of water and land; Port planning and management; Long-term wave analysis; Rubble construction; Rubble breakwaters; Interaction between waves and structures; Stability of exposed and submerged rubble breakwaters; Stability of coatings; Vertical-wall breakwater; Interaction between waves and structures; Coastal engineering; Geomorphology; Coastal protection work; Longitudinal dynamics; Transverse dynamics; Port-coast interaction; Coastal response; Accretion in ports; Interaction in pocket beaches; Interaction with secondary waves; Beach nourishment

The main objectives within this framework can be summarized as follows:

- * Present basic concepts, tools and engineering solutions for harbour and coastal engineering.
- * Introduce the main meteo-oceanographic factors responsible for coastal evolution and which act as the main controlling terms for the design of harbor/coastal engineering structures and works. These factors include:
 - Wind-generated waves
 - Astronomic and meteorological tides
 - Circulation and associated transport
- * Present the most common harbour engineering structures, together with the state-of-art formulations and models for their functional and resistant design. Introduce the concept of probabilistic design and the reliability of the corresponding structure. The main harbor structures considered are:
 - Mound structures
 - Vertical structures
- * Introduce the main types of structures and construction materials used in offshore engineering. The emphasis will be on the following types:
 - Fixed structures
 - Floating structures
- * Present the most common structures or works employed in coastal engineering, together with the state of art formulations and models for their functional and resistant design. The analysis will be based on longshore and cross-shore sedimentary fluxes and will include the following coastal works:
 - Groins
 - Detached brackwaters
 - Artificial nourishment
- * Present the Catalan coast case, with its high level of uses and conflicts and its high variety of coastal geomorphology and engineering solutions. Apply the tools and concepts introduced previously to assess the morphodynamic and water quality impact of some well known engineering structures. This will be followed by tutored course work, in which the students will have to prepare a small analysis of the design and impact of some civil engineering structure or coastal work. This analysis will be submitted in written form and presented in front of the class at the end of the course.

STUDY LOAD

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



Type	Hours	Percentage
Self study	84,0	56.00

Total learning time: 150 h

CONTENTS

Introduction to coastal harbour and offshore engineering

Description:

- Civil Engineering at sea
- The coastal zone
- Decisions in the face of uncertainty
- Ethics in maritime engineering

Specific objectives:

The aim in here is to present the coastal zone as an area where multiple activities coexist and where there often is a conflict between natural processes and rigid infrastructures. We shall present the main civil engineering activities in this area and describe the main driving terms and how they interact with structures and geomorphology.

The limited knowledge about driving terms and natural processes will also be presented, showing the need to take decisions in the face of uncertainty. This will provide the basis for some considerations on the need for ethics in maritime engineering.

Full-or-part-time: 2h 24m

Theory classes: 1h

Self study : 1h 24m



Wind-waves

Description:

Regular waves: theories, parameterizations and limits.

Irregular waves: conceptual model and short-term distributions

Irregular waves: long-term and extreme distributions

Wave climate: conditions along the Spanish coast

Wave propagation: refraction, diffraction and reflection

Wave breaking: depth-induced and wind induced

Wave generation and forecasting: concepts and models

Irregular Waves: Conceptual Models in the short term and description

Breaking the waves: rupture and breakdown by funds generated by wind and wave forecast: Concepts and Models

Specific objectives:

The main aim here is to present the deterministic and probabilistic descriptions used nowadays for wind generated waves. We shall start with regular wave theories, the available parameterizations and the limits of application for the main sets of equations. The students will get familiar with linear wave theory and how it is applied to obtain velocities, accelerations, pressures... This will be followed by the conceptual model to describe irregular waves and the short term probabilistic distributions that result. The next step is to describe in probabilistic terms the average and extreme wave conditions, showing the students the most commonly employed distributions and how their parameters are fitted to de available records.

The next element is the propagation of waves from the offshore areas, where they are forecast or measured, towards the coast where there is an engineering need to design harbors, beaches, etc. The physics of refraction will be studied in depth, presenting the equations for long shore uniform conditions and an arbitrary varying bathymetry. The mild slope simplification will also be presented. This will be followed by a short description of diffraction and reflection and how they become critical in, for instance, predicting wave conditions inside of a harbor.

The next block will present wave breaking due to depth control and, secondarily, due to excess wind shear stress over the sea surface. The emphasis will be on depth induced breaking near the coast and how this affects wave conditions and their selection for the design of coastal and harbor structures.

introduce students to the long-term and probabilistic descriptions of extremes for the same waves, showing students the need to use probabilistic distributions, the main types and parameters that are recommended based on available data.

Generation and wave forecast, reviewing the available models and how to obtain these predictions from meteorological institutions as the Spanish Meteorological and Transportation of the State, the Meteorological Service of Catalonia and ECMRWF.

Full-or-part-time: 33h 36m

Theory classes: 8h

Practical classes: 4h

Laboratory classes: 2h

Self study : 19h 36m



Other hydrodynamic processes

Description:

Long waves: origin and range of motions

Long waves: modelling and applications

Tides: concepts and description

Circulation: origin and range of motions

Circulation: modelling and applications

Transport: Eulerian and Lagrangian approaches

Specific objectives:

The aim in this block is to present oscillations long wave and current type motions, which are also important elements in the design (for instance harbor resonance) and exploitation of maritime structures and also in their impact evaluation on sediment dynamics. The class will start by presenting the various origins and main features of long wave motions. This will be followed by the modeling of long waves in shallow water areas, with some practical applications, for instance to tsunamis.

The next element are tides including meteorological and astronomical tides, how they are generated and how they can be predicted. The class will follow with an overview of coastal circulation, its various origins and types of motion and how to apply the available models for their simulation. This will also include a short description of mixing and dispersion and the resulting transport patterns, for instance for sea outfalls, including Eulerian and Lagrangian descriptions.

Full-or-part-time: 9h 36m

Theory classes: 4h

Self study : 5h 36m

Harbour engineering

Description:

Harbour types. Water and land areas

Mound structures: Resistent design

Mound structures: Functional design

Mound structures: Construction and foundation

Vertical structures: Resistent design

Vertical structures: Functional design

Field visit vertical structures: Construction and foundation

Mound structures and vertical structures

Mound structures and vertical structures

Specific objectives:

The class will start presenting the various types of harbors, discussing the specifics of their land and water areas. This will be followed by an analysis in depth of mound structures, covering resistant functional and constructive (even foundation) elements. The same approach will be used for vertical structures, covering resistant, functional and constructive elements (including also foundation).

In this block there will be a field visit to the Barcelona harbour, where an overview of the harbour land and water areas and exploitation will be presented. This will be followed by a visit to mound and vertical structures and a discussion of their advantages and disadvantages.

Full-or-part-time: 26h 24m

Theory classes: 4h

Practical classes: 4h

Laboratory classes: 3h

Self study : 15h 24m



Offshore engineering

Description:

Structures and environments. Construction materials

Loads

Motions

Fixed structures

Floating structures

Specific objectives:

The class will present the various structural types and building materials as a function of water depth, tradition and present preferences. This will be followed by a presentation of analytical and numerical methods to evaluate wave loads. The next block deals with the wave induced motions, both linear and drift trajectories. The class will end with an illustration for fixed and floating structures.

Full-or-part-time: 4h 48m

Theory classes: 2h

Self study : 2h 48m

Coastal engineering

Description:

Types of coasts. Geomorphology

Types of structures and works

Longshore sediment transport and cost-line dynamics

Crossshore sediment transport and profile dynamics

Groynes

Detached breakwaters

Artificial nourishment

Bypasses

Other coastal works

Longshore and corsshore sediment transport

Groynes and detached breakwaters

Specific objectives:

The aim of this class is to present the main geomorphologies found in our coasts and the engineering solutions commonly employed in present coastal projects. This will be followed by a review of long-shore and cross-shore sediment transport formulations, emphasizing their role as predictors of the potential transport capacity rather than the actually occurring fluxes. The class will also introduce the students to the dynamics of the coastal zone in plan and profile. The next block of the class will introduce the students to the structural concepts nowadays available: perpendicular and parallel groins, artificial nourishment, sediment by-passes and other types of coastal actions (promenades, vegetated dunes, ...).

Full-or-part-time: 38h 24m

Theory classes: 7h

Practical classes: 8h

Laboratory classes: 1h

Self study : 22h 24m



The catalan coast case

Description:

Catalan coast: Introduction and course work
Harbour-beach interactions
Morphodynamic impact
Water quality impact
Course work

Harbour-beach interactions

Specific objectives:

The aim of this block of classes is to introduce the students into the dynamics and problems of a coastal zone like the Catalan sea border, where there is a variety of geomorphic environments and engineering solutions. The harbour and beach interactions will be illustrated with a real case, from which the students will learn how to evaluate the impact on morphodynamics and on water quality.

The next block of the class is to apply these concepts and tools presented during the course, course work directed.
Interactions Harbour-Beach

Full-or-part-time: 28h 47m

Theory classes: 4h
Laboratory classes: 8h
Self study : 16h 47m

GRADING SYSTEM

The assessment will consist of three blocks:

- 1) A first partial exam with 5 to 10 short questions and personalised calculations (e.g. depending on the personal identification number) to be taken remotely or face-to-face and handed in after 1,5 to 2,5 hours. The emphasis will be on problem solving with some calculations. This is how mark 1 is obtained.
- 2) A second partial exam with short questions and personalised calculations (e.g. depending on the personal identification number) to be taken remotely or face-to-face and handed in after 1,5 to 2,5 hours. The emphasis will be on problem solving with some calculations. This is how grade 2 is obtained.
- 3) Oral presentations of the organised Course Work Groups, with 3 students per group. Presentations will be scheduled in due time and each group will have 15 minutes allocated for the presentation, during which all students should participate. This will be followed by 15 minutes of questions on course work and related topics from the course programme. One member of each group will upload the tutored project report together with supporting images (images plus written memory) to Athena. All this, together with the marks for the optional coursework, will form the grade 3.

The final grade will be obtained as: $\text{Grade1} \times 0.4 + \text{Grade2} \times 0.4 + \text{Grade3} \times 0.2$. Those who do not pass will have to resit the exam when it is duly called. The structure will be similar, but it will consist of blocks 1 and 2 only.

EXAMINATION RULES.

Marks will range between 10 (top) and 0 (lowest).

The test exam will give approximate equal weight to the conceptual questions and to the application exercises. The tutored course work will be evaluated from the written report and the oral presentation. Different marks may be given to different members of the team, based on their respective contributions to the team work. The lab activities will be individually evaluated.

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



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