Course guide
250575 - INSTANDACM - Instrumentation and Data Analyses in Marine Sciences

Unit in charge: Barcelona School of Civil Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering.
Degree: BACHELOR’S DEGREE IN MARINE SCIENCE AND TECHNOLOGY (Syllabus 2018). (Compulsory subject).
Academic year: 2022  ECTS Credits: 6.0  Languages: Catalan

LECTURER

Coordinating lecturer: JOAQUIN DEL RIO FERNANDEZ
Others: MATIAS CARANDELL WIDMER, JOAQUIN DEL RIO FERNANDEZ, MARC NOGUERAS CERVERA, DANIEL MIHAI TOMA

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
13388. To know and apply the lexicon and concepts of the Marine Sciences and Technologies and other related fields.
13390. Establish a good practice in the integration of common numerical, laboratory and field techniques in the analysis of any problem related to the marine environment.
13394. Address the most relevant processes and their interactions related to their physical / chemical / biological / geological components, applying technical and scientific knowledge and criteria.
13397. Carry out environmental impact, management and protection studies of the marine environment and adjacent coastal areas, including the corresponding infrastructures and their related impacts.
13403. Develop a conceptual framework to address the sustainability of the marine environment and the related socio-economic activities at different scales, explaining the effects of climate change.
13404. Set, plan and execute basic and applied research in the field of Marine Sciences and Technologies.
13405. Carry out calculations, assessments, surveys and inspections in coastal and marine environments, as well as the corresponding technical documents.
13406. Write technical reports and disseminate knowledge about the different components of the marine system, considering the applicable legal framework.

Generical:
13382. Apply state-of-the-art methods and techniques in oceanography and marine climate, jointly covering the physical, chemical, geological and biological aspects.
13383. Develop a conceptual framework that links the scientific-technological and management aspects for marine resources, explaining the interactions with marine infrastructures and management plans in coastal areas.
13384. Apply knowledge and academic experience to the control and monitoring of the marine environment and its coastal boundary, using the state-of-the-art tools in the Marine Sciences and Technologies.
13386. Encompass and teach studies in the different research lines that converge in Marine Sciences and Technologies.
13387. Combining preservation with economic activity within the framework of current legislation promoting the development of a social and environmental awareness.
TEACHING METHODOLOGY

The course consists of 2.3 hours per week of classroom activity (large size group) and 1.2 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 1.2 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

In this subject students will be shown the different measurement devices that are used in measurement campaigns in Oceanography and Maritime Engineering to obtain data on meteo-oceanographic parameters such as conductivity, temperature, salinity, turbidity, dissolved oxygen, pH, pressure, speeds, etc. Subsequently, different filtering and data validation techniques will be studied at different levels (verification of ranges and outliers, temporal coherence, coherence between variables, temporal coherence of the series, and spatial coherence). Finally, different data analysis and representation techniques will be seen.

1. Understand the methodologies of analysis and data collection in oceanography.
2. Know the oceanographic measuring systems, their characteristics and applications.
3. Understand the methodologies of time series analysis in the time and frequency domains.

This subject is focused on showing, familiarizing and training students with techniques of observation, monitoring, acquisition and treatment of marine data, as well as modeling techniques, physical and numerical, which allow to characterize practically all of the real problems that will have to address in the professional practice and that will allow the students to finish a generic training cycle but with advanced and transversal knowledge in Sciences and Technologies of the Sea.

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours medium group</td>
<td>15,0</td>
<td>10.00</td>
</tr>
<tr>
<td>Hours large group</td>
<td>30,0</td>
<td>20.00</td>
</tr>
<tr>
<td>Hours small group</td>
<td>15,0</td>
<td>10.00</td>
</tr>
<tr>
<td>Self study</td>
<td>84,0</td>
<td>56.00</td>
</tr>
<tr>
<td>Guided activities</td>
<td>6,0</td>
<td>4.00</td>
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Total learning time: 150 h
Introduction to Marine Instrumentation Systems

Description:
Different types of observation platforms used to integrate the marine instrumentation that we will use to make measurements of oceanographic parameters are described. Different types of platforms will be described: fixed, mobile, autonomous, wired observatories, platforms for making measurements in-situ or remotely, surface, background, etc ...
Observation platforms, depending on the characteristics, can offer different capabilities when integrating different types of measuring instruments. This session will describe the most important features in terms of autonomy, power systems, wired or wireless communication systems, flotation, anchoring, etc ...

Specific objectives:
Know the types and characteristics of marine observation platforms. Know and be able to describe the capabilities of a marine observation platform. Have criteria for deciding which type of platform is most suitable for carrying out different types of oceanographic measurements or experiments.

Full-or-part-time: 9h 36m
Theory classes: 4h
Self study : 5h 36m

Characteristics of the Instrumentation used in measurement systems

Description:
The measurement procedure and method used by an instrument is associated with certain characteristics such as the resolution, uncertainty or accuracy of the measurement. This session will explain these concepts and how to use them for a correct interpretation of the measures.
In order to integrate an instrument into an observation platform it is necessary to take into account different aspects about communications, power supply, autonomy, as well as the weight, buoyancy or even hydrodynamic characteristics of the instrument. This session describes all these features and how the instrument manufacturer provides them.

Specific objectives:
To know the characteristics associated with a measurement procedure and its interpretation. Know the basic characteristics needed for an instrument to be integrated into an observation platform.

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Instruments for measuring meteoceanographic parameters

Description:
In this session there will be a detailed description of the different instruments most commonly used to make measurements at sea such as conductivity, temperature, salinity, turbidity, dissolved oxygen, pH, pressure, currents, waves, underwater noise.
Examples of commercial instrumentation are described in this session, and the state of the art in the measurement of different types of variables since physical variables such as temperature or depth follow well-established and traceable procedures, but other biological variables or chemicals still require sampling and in-situ measurement is not yet feasible.

In this lab session, knowledge about serial communications with an instrument such as the CTD, its configuration, and data reading is put into practice.
In this laboratory session, knowledge about serial communications with an instrument such as the weather station, its configuration, and data reading is put into practice, in order to finally be able to generate standard data files.
In this laboratory session, knowledge about serial communications is put into practice with an instrument such as the current meter, its configuration, and data reading, in order to finally be able to generate standard data files.
In this laboratory session, knowledge about serial communications with an instrument such as the hydrophone, its configuration, and data reading is put into practice, in order to finally be able to generate standard data files.

Specific objectives:
Know the instruments that are usually used to make measurements at sea. Interpret correctly how they work, their capabilities and limitations.
Know the commercial instrumentation and its characteristics.
Be able to set up and implement a CTD and perform real-time measurements or data download.
Be able to set up and operate a weather station and perform real-time measurements or data downloads.
Be able to set up and run a current meter and perform real-time measurements or data download.
Be able to set up and operate a hydrophone and perform real-time measurements or data download.

Full-or-part-time: 86h 24m
Theory classes: 12h
Laboratory classes: 24h
Self study : 50h 24m
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Electronic systems associated with instrumentation

Description:
This session describes the different protocols, mechanisms and devices used in marine instrumentation: From the most common wired communication systems such as serial or ethernet communication buses, to describing how wireless acoustic communications are implemented underwater, or wireless communications capabilities out of the water using satellites or mobile phone protocols.
This session describes the different options for energizing an observation platform and how it provides energy to the instrumentation used. The characteristics of wired or stand-alone power systems that can use renewable batteries or energy sources are described.

Specific objectives:
Know the characteristics and capabilities of communication systems. Be able to choose which communication system may be most appropriate depending on the measurement requirements and the location of the instrumentation.
Know the characteristics and limitations of the energy systems used in observation platforms.

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Data time series processing

Description:
Once the measuring instruments transmit the information, it will be stored digitally to be processed: This section describes the most common formats with which to store datasets such as CSV, NetCDF, O & M, etc... This session describes some of the computer tools used such as Ocean Data View among others. Statistical methods for the detection of errors that allow a correct filtering and visualization of the data generated by the measuring instruments are presented in this session. Quality control methods based on range and outliers verification, temporal coherence, coherence between variables, temporal coherence of series, and spatial coherence are described.
In this session, algorithms will be implemented to perform quality control of different types of variables and based on the verification of ranges and outliers, temporal coherence, coherence between variables, temporal coherence of the series, and spatial coherence.

Specific objectives:
Know the di
Know the basic operation of some computer applications for data representation.
Know basic techniques for the detection and filtering of aberrant measures, offset or drifts.
Know the methods applied by the scientific community for data quality control.
Learn to program data quality control algorithms.

Full-or-part-time: 28h 47m
Theory classes: 6h
Laboratory classes: 6h
Self study : 16h 47m
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GRADING 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.

BIBLIOGRAPHY
Basic: