

# Data Management: Communications, Programming and Simulation (250592)

## General Information

|                    |   |
|--------------------|---|
| <b>School</b>      | ETSECCPB  |
| <b>Departments</b> | Departament d'Enginyeria Electrònica (EEL)<br>Departament d'Enginyeria Telemàtica (ENTEL) |
| <b>Credits</b>     | 6.0 ECTS  |
| <b>Programs</b>    | GRAU EN CIÈNCIES I TECNOLOGIES DEL MAR (pla 2018)   |
| <b>Course</b>      | 2024/25   |

## Main teaching language at each group

- Group 10CA1 Catalan (Q1)

## Faculty

Responsible Faculty: Daniel Mihai Toma Lesenciuc

Faculty: Enoc Martínez Padró, Daniel Mihai Toma Lesenciuc, Rafael Vidal Ferré

## Objectives of Education

This subject will show aspects related to software solutions for a reliable and efficient communication with continuous monitoring systems in the marine environment, the correct collection of data (acquired in real time), and its management to administer, control, analyze and safely store all information related to the monitoring of marine environmental parameters. Emphasis will be placed on the persistence of data over time and on the application of the FAIR principles.

1. Know the most common communication buses and protocols in marine instrumentation, the configuration for data reading and recording.
2. Have the ability to design computer applications for task automation through programming languages such as C, Python or LabVIEW
3. Know the operation of modeling and simulation tools, applied to moorings, as well as their boundary conditions (location of an anchorage: depth, currents, waves and winds)
4. Reflect on the problems in the design and programming of applications that are executed in an unattended manner that should work for long periods of time without interaction with a user.
5. Know the characteristics of communication systems (wired and wireless) used in marine observation platforms
6. Know and use equipment and technology used in geolocation systems, data communication (via satellite, GSM, radio, point-to-point link, etc.)

This subject is oriented to the application of technologies of observation, remote perception and automatic exploration of the marine environment, which is essential for the motorization of the coastal water bodies and the obtaining of the necessary data for the control of practically all the activities human resources in the marine environment related to the exploitation of natural and aquacultural resources of the marine and coastal environment.

## Competencies

### Especific

To know and apply the lexicon and concepts of the Marine Sciences and Technologies and other related fields.

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.

Participate and eventually lead multidisciplinary work teams in the field of Marine Sciences and Technologies to respond to the social challenges related to this field.

Address the most relevant processes and their interactions related to their physical / chemical / biological / geological components, applying technical and scientific knowledge and criteria.

Carry out environmental impact, management and protection studies of the marine environment and adjacent coastal areas, including the corresponding infrastructures and their related impacts.

Apply the state-of-the-art numerical and statistical techniques in the coastal and marine fields for a correct interpretation of data. (Specific competence of the Marine Technologies Mention)

Apply spatial and cartographic representation techniques for different environments and scales.

Use and apply indicators to assess impacts, both natural and anthropogenic, and propose corrective measures with monitoring and surveillance programs. (Specific competence of the Marine Technologies Mention)

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.

Set, plan and execute basic and applied research in the field of Marine Sciences and Technologies.

Carry out calculations, assessments, surveys and inspections in coastal and marine environments, as well as the corresponding technical documents.

Write technical reports and disseminate knowledge about the different components of the marine system, considering the applicable legal framework.

Apply the necessary tools to analyze the economic and legal aspects of human actions and the related impacts on the marine environment, including technical advice and representation of companies and administrations.

## Generic

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.

Encompass and teach studies in the different research lines that converge in Marine Sciences and Technologies.

Combining preservation with economic activity within the framework of current legislation promoting the development of a social and environmental awareness.

## Total hours of student work

|                     |                    | Hours   | Percentage |
|---------------------|--------------------|---------|------------|
| Supervised Learning | Large group        | 40.02 h | 66.70 %    |
|                     | Medium group       | 0.0 h   | 0.00 %     |
|                     | Laboratory classes | 19.98 h | 33.30 %    |
|                     | Guided Activities  | 0.0 h   | 0.00 %     |
| Self Study          |                    | 90.0 h  |            |

## Contents

### Information systems in the world of marine observation

Data of interest (depth, currents, waves, winds); data vs. metadata (timestamps, geolocation); data acquisition systems (instrumentation, sensors; autonomy, unattended operation); data transmission systems (communication networks); data exploitation (programming, Internet); simulation (modeling, tools).

### Communications networks

Definition of concepts. Components of a network and basic functions it performs. Information (encoding and data formats). Fundamental parameters to assess its operation: capacity, latency, losses and consumption. Types of networks based on interconnection systems, range and transmission medium (copper, fiber and radio). Switching. Delay (latency) in communication, definition and estimation. Architecture of a computer network. ISO OSI model. Interconnection equipment.

## **Internet**

TCP / IP protocol stack. Bases of operation (addressing and routing). Network layer (IP and ICMP protocols, address types). Transport layer (ports and connections, UDP vs TCP) Application layer (Web and DNS).  
Internet

## **Wired networks: buses and Ethernet**

General characteristics of the physical and linkage levels (MAC and LLC); field buses (general characteristics, RS-232, RS485); Ethernet (LAN concept, frame format, broadcast, switching).  
Wired networks: buses and Ethernet

## **Wireless networks: GNSS and data transmission**

Radio spectrum, regulation; basic concepts (attenuation, coverage) technologies and use cases. GNSS (GPS, GLONASS, Galileo, Beidu); WWANs (2-5G mobile communications networks); WLANs (Wi-Fi); WPANs (Bluetooth, IEEE802.15.4, UWB); LPWANs (Sigfox, LoRaWAN, NB-IoT), GLOVES (satellite)  
Wireless networks: GNSS and data transmission

## **Variables, expressions and errors**

Familiarize with basic programming concepts such as variables and expressions. Variable types and python interpreter errors  
Variables, expressions and errors

## **Strings, lists, dictionaries**

Familiarize yourself with strings, lists, and python dictionaries.  
Strings, lists, dictionaries

## **Conditional, execution, iteration**

Familiarize yourself with the execution flow of a program, conditionals, if / else structures, for, while, and so on.  
Conditional, execution, iteration

## **Libraries, functions**

Learn to import basic libraries (math, time, random), learn to generate own functions.  
Libraries, functions

## **File operations**

Open, read, create files and modify. Different types of files to store data (CSV, JSON, NetCDF). Open and process data in CSV files. Folder generation and automatic organization of files in folders.  
File operations

## **Classes, objects**

Learn that it is a class, that it is an object. Simple class generation. Import classes and use classes from a library.  
Classes, objects

## **Pandas + Matplotlib**

Familiarize yourself with the Pandas data processing library and dataframe structures. Simple methods (resample, slice, etc.). Introduction to the Matplotlib library for making graphs with data: lineplot, scatter and correlation.  
Pandas + Matplotlib

## **HTTP with Requests, Telegram**

Introduction to the requests library for working with HTTP. Basic HTTP operations (post, get, patch, delete). Use requests in conjunction with the Telegram API to automate messaging service.  
HTTP with Requests, Telegram

## **Requests + Pandas + Matplotlib + Telegram**

Final exercise in which HTTP is used to download data automatically from a data service (eg ERDDAP or CKAN), use Pandas to import data, process it, generate graphs with Matplotlib and send it to via Telegram on mobile phone.

Requests + Pandas + Matplotlib + Telegram

## **Simulation modelling of communication systems**

Analyse and review complex networking systems and understand the theoretical underpinning of simulation and gain competency in the use of a simulation package. This module will focus on the transport of multimedia traffic over a variety of communication networks. It will concentrate on the relationships between different types of multimedia traffic, network infrastructures and network protocols in regard to achieving the required Quality-of-Service parameters for multimedia applications. Emphasis will be given to modern high speed communication networks designed to carry high volumes of heterogeneous traffic. LAN/MAN/WAN models with various protocols and different multimedia traffic will be developed and simulated to investigate the behaviour and limitations of such networks.

Simulation modelling of communication systems

## **Teaching Methodology**

The course is divided into:

-Theory classes and problems in which the different topics will be exposed, the fundamental concepts will be explained and problems will be realized where to apply the acquired knowledge.

-Laboratory classes where some of the theoretical knowledge presented will be illustrated in a practical way.

Detailed teaching materials will be used through the Atenea virtual campus, both at the theoretical and laboratory practice level

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.

## **Grading Rules**

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

The qualification of the subject is obtained from the qualifications of the tests of partial and final evaluation, of the qualifications of follow-up and of continuous evaluation and of the qualifications corresponding to the activities in the laboratory.

The continuous evaluation consists of doing different activities, both individual and group, of an additive and formative nature, carried out during the course (inside the classroom and outside it).

The qualification of teaching in the laboratory is the average of such activities.

Assessment tests consist of a part with questions about concepts associated with the learning objectives of the subject in terms of knowledge or comprehension, and a set of application exercises.

NF = 50% Theory Note + 10% Monitoring Notes + 40% Laboratory Note

Theory note: evaluation tests

Follow-up notes: exercises and works presented during the course

Laboratory note: previous studies and reports on the practices.

Criteria of qualification and of admission to the re-evaluation: The students suspended in the ordinary evaluation that have presented regularly in the proofs of evaluation of the asignatura suspended will have option to realize a proof of re-evaluation in the period fixed in the academic calendar

Students who have already passed it or students who have qualified as not presented will not be able to take the re-assessment test for a subject. The maximum grade in the case of taking the re-assessment exam will be five (5.0). The non-attendance of a student summoned to the re-evaluation test, held in the fixed period may not lead to the performance of another test with a later date. Extraordinary evaluations will be carried out for those students who, due to force majeure, have not been able to take any of the continuous assessment tests.

These tests must be authorized by the corresponding head of studies, at the request of the teacher responsible for the subject, and will be carried out within the corresponding teaching period.

## **Office Hours**

The opening hours will be set at the beginning of the course

## **Bibliography**

### **Basic**

- McKinney, Wes. Python for data analysis : data wrangling with pandas, NumPy & Jupyter. 3rd edition. Sebastopol: O'Reilly Media, Inc, USA;, 2022. ISBN 9781098104009.