Meteo-Oceanographic Time Series: Time and Frequency Analyses (250615)

General information

School:	ETSECCPB
Departments:	Departament d'Enginyeria Civil i Ambiental (DECA)
Credits:	2.0 ECTS
Programs:	MÀSTER UNIVERSITARI ERASMUS MUNDUS EN ENGINYERIA I GESTIÓ COSTANERA I MARÍTIMA, pla 2022 - (codi pla 1525)
Course:	2023/2024

Main teaching language at each group

- Group 10Q2 English (Q2)

Faculty

Responsible faculty: Octavio Cesar Mösso Aranda

Teachers: Octavio Cesar Mösso Aranda, Marc Sanuy Vázquez

Generic objectives

This course is focused on the study of a sequence of observations in form of a time series with emphasis on relevant meteo-oceanographic processes. The study of a given meteo-oceanographic signal will be done under two different approaches, which are associated with time domain (i.e. trend component) and frequency domain (i.e. periodic component).

Skills

Specific skills

Perform time and frequency domain analysis of MetOcean data to provide operational and design values.

Know how to make the stakeholders and community to work together to make a project acceptable and wanted.

Coastal hydrodynamics and processes.

Short-term and long-term wave climate.

Tidal currents.

Field campaigns and data treatment to evaluate problematic situations and plan/design solutions.

The basis behind climate change and its effect on the coast.

Design coastal interventions.

Understand and predict the impacts of coastal interventions.

Analyse and interpret collected field data in order to understand the physical drivers at short, mid and long-time or climatic scales.

Compute the risk, vulnerability and hazard analysis including the decadal (climatic) scale.

Generic skills of subject

Develop knowledge and understanding of the coastal environment at an advanced level, applying classic (hard and soft) coastal engineering complemented with building with nature concepts, with ability to analyse, evaluate, assess and synthesis of data and information from different sources with contemporary techniques and technologies.

Handle engineering problems dealing with waves, currents, their interactions, their effects on the coastline and man-made interventions, spanning from short (storms) to decadal scales, to incorporate the climate change dimension.

Propose creative and innovative solutions by themselves or as a work group for current and future problems by enhancing their own interpersonal understanding, work as a team and oral and written communication skills.

ECTS credits: total hours of student work

		Dedication	
		Hours	**Percent**
Supervised Learning	**Theory**	10.00	55.6%
	Assignments	4.00	22.2%
	Laboratory	4.00	22.2%
	Supervised activities	0.00	0.0%
Self-Learning		32.00	

Contents

1.- Introduction to time series

Dedication

1.0h. Theory

Description

Description of the Time Series. What information can be obtained based on the length and frequency of sampling. How can the underlying information be determined?

Objectives

Description of time series. Importance of run length and sampling frequency

2.- Statistical Concepts

Dedication

1.0h. Theory + 1.0h. Assignments + 1.0h. Laboratory

Description

The importance of some fundamental statistical concepts for the correct analysis of time series will be shown. Concept of hypothesis testing

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Objectives

Review of statistical concepts such as variance, covariance, autocovariance, correlation, autocorrelation, expectation value and p-value.

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3.- Visual Inspection Techniques

Dedication

1.0h. Theory + 1.0h. Assignments

Description

The different ways of graphing time series will be shown to show the different information that can be obtained

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Objectives

Time Series Charts Rose Charts Progressive Vector Charts and Sliver Diagrams Correlation Maps

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4.- Concept of stationarity and non-stationarity

Dedication

2.0h. Theory + 1.0h. Assignments

Description

The importance of determining if the series is Stationary or not Stationary will be shown, as well as the different techniques to achieve the Stationarity of the Series

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Objectives

Importance of Stationarity Number of turning points Randomness Correlogram

Importance of Stationarity Number of change points. Randomness Correlogram

5.- Analysis in the Time Domain. Linear Trend

Dedication

1.0h. Theory + 1.0h. Assignments + 1.0h. Laboratory

Description

The different linear trend estimation techniques will be shown, with parametric and non-parametric tests. Special emphasis will be placed on the Mann-Kendall technique and Sen's Slope

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Objectives

Visual inspection of the series (determine if there is a trend or not) Parametric Models (linear and non-linear) Linear Non-Parametric Model (Mann-Kendall test and Sen's slope)

Visual inspection of the series (determine if there is a trend or not) Parametric Models (linear and non-linear) Non-Parametric Linear Model (Mann-Kendall Test and Sen's slope)

Visual inspection of the series (determine if there is a trend or not) Parametric Models (linear and non-linear) Non-Parametric Linear Model (Mann-Kendall Test and Sen's slope)

6.- Analysis in the Time Domain. Non Linear Trend

Dedication

1.0h. Theory + 1.0h. Laboratory

Description

The different non-linear trend estimation techniques will be shown.

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Objectives

Moving Media Filtering Techniques Band Pass Filter Hodrick Prescott Filter

Moving Average Filtering Techniques Band Pass Filter Hodrick Prescott

7.- Analysis in the Frequency Domain. Spectral Analysis

Dedication

3.0h. Theory + 1.0h. Laboratory

Description

The technique for the analysis of a signal in the frequency domain by means of the fast Fourier transform will be shown. Concept of the Nyquist Frequency. Obtaining the spectrum and its interpretation.

The technique for analyzing a signal in the frequency domain using the fast Fourier transform will be shown. Concept of the Nyquist Frequency. Spectrum acquisition and interpretation

Objectives

Show the technique of the Fourier Transform Nyquist Frequency Obtaining and Interpreting the Spectrum

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Activities

Grading rules (*)

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

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.

Test rules

Teaching methodology

The course consists of 0.8 hours per week of classroom activity (large size group) and 0.3 hours weekly with half the students (medium size group).

The 0.8 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 0.3 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.

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.

Basic bibliography

- Liu, Z., & Frigaard, P.. **Generation and Analysis of Random Waves.**. Aalborg Universitet. 1999.