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33104 - TAEDDPE - Techniques of Statistic Analysis of Data and Design and Planning of Experiments

Coordinating unit: 330 - EPSEM - Manresa School of Engineering

Teaching unit: 749 - MAT - Department of Mathematics

Academic year: 2019

Degree: MASTER'S DEGREE IN NATURAL RESOURCE ENGINEERING (Syllabus 2008). (Teaching unit Compulsory)
MASTER'S DEGREE IN NATURAL RESOURCE ENGINEERING (Syllabus 2015). (Teaching unit Compulsory)
MASTER'S DEGREE IN NATURAL RESOURCE ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)

ECTS credits: 5 Teaching languages: Spanish

Teaching staff

Coordinator: JOSEP MARIA ROSSELL GARRIGA

Degree competences to which the subject contributes

Specific:

1. The ability to analyse field and laboratory data and design experiments using computer methods.

2. A capacity for understanding analytical techniques for the characterisation of inorganic natural resources and waste in different states, using these techniques and interpreting the results.
3. The ability to use scientific and technical information to respond efficiently to any demand for the preparation of an analytical method for characterising a material of natural or anthropogenic origin.

Teaching methodology

The main aim of the course is to familiarise students with statistical processes, both the theory and more practical aspects. Basic statistical concepts and tools are introduced and/or revised that allow us to take samples, manipulate data, analyse results, make statistical inferences, design experiments and work with time series, following statistical protocols at all times. The data that we work with throughout the course are essentially of an environmental nature.

The Minitab program for data manipulation is used in the most practical part of the course. Students are given a CD containing the program and a manual in PDF. The download of the Minitab program complies with current legislation, since students enrolled in a master's degree at the Universitat Politècnica de Catalunya (UPC) have the right to install and use the aforementioned software for free and personal use.

In the lectures, the professor introduces the theory, concepts, methods and results pertaining to the subject and illustrates them with examples that aid comprehension. Students must make a personal effort to assimilate the concepts independently and solve the exercises proposed with the help of a computer.

In face-to-face sessions the professor solves any queries that have arisen during students' independent learning.

Learning objectives of the subject

On completion of the subject Statistical Data Analysis Techniques and Experimental Design and Planning, students must be able to:

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-Take a reliable and satisfactory sample of a data set.
-Analyse a data set correctly from both graphic and numerical points of view.
-Draw conclusions based on the results obtained from the actions mentioned above.
-Interpret the results obtained and extrapolate them using statistical inference tools.
-Formulate and solve multivariate statistics problems.
-Formulate and solve multiple regression problems.
-Formulate and solve simple experimental design and analysis problems.
-Formulate and solve time series problems.
-Use appropriate statistical tools to deal with the general statistical problems described above.

Study load

Total learning time: 45h	Hours large group:	30h	66.67%
	Hours medium group:	15h	33.33%

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Content

Topic 1: Descriptive statistics: sampling and measures of position and dispersion

Learning time: 13h

Theory classes: 4h
Laboratory classes: 1h
Self study : 8h

Description:
1. Introduction to descriptive statistics. Types of statistical variables
2. Sampling techniques
3. Measures of position
4. Measures of dispersion

Related activities:
Activity A1

Graphic representation of data

Learning time: 11h

Theory classes: 4h
Laboratory classes: 1h
Self study : 6h

Description:
1.The usefulness of graphic representation in statistics
2.Graphs for discrete variables. Interpretation
3.Graphs for continuous variables. Interpretation
4.Other types of statistical graphics. Interpretation

Related activities:
Activity A2

Topic 3: Linear and non-linear regression. Curve fitting

Learning time: 19h

Theory classes: 6h
Laboratory classes: 1h
Self study : 12h

Description:
1.Linear regression. Pearson coefficient and coefficient of determination
2.Non-linear but linearisable regression
3.Curve fitting

Related activities:
Activity A3

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Topic 4: Special distributions

Learning time: 13h

Theory classes: 4h
Laboratory classes: 1h
Self study : 8h

Description:
1.Random variables
2.Discrete distributions: uniform, binomial, geometric, Poisson
3.Continuous distributions: normal, t-Student, Chi-square, F-Fisher

Related activities:
Activity A4

Topic 5: Statistical inference: confidence intervals and hypothesis testing

Learning time: 20h

Theory classes: 6h
Laboratory classes: 2h
Self study : 12h

Description:
1.Prior concepts in statistical inference
2.Confidence intervals of averages, variances and proportions
3.Hypothesis testing of an average, a variance and a proportion
4.Hypothesis testing of two averages, two variances and two proportions

Related activities:
Activity A5

Topic 6: Concepts in multivariate statistics

Learning time: 17h

Theory classes: 4h
Laboratory classes: 1h
Self study : 12h

Description:
1.Introduction to multivariate statistics. Prior concepts
2.Initial data exploration
3.Analysis techniques. Analysis of dependence
4.Multiple linear regression

Related activities:
Activity A6

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Topic 7: Experimental design and analysis	Learning time: 17h Theory classes: 4h Laboratory classes: 1h Self study : 12h

Description:
1.Introduction to experimental design
2.Single-factor experiments
3.Introduction to factorial design
4.2k factorial design

Related activities:
Activity A7

title english	Learning time: 15h Theory classes: 4h Laboratory classes: 1h Self study : 10h

Description:
1.Introduction to time series
2.Time series decomposition
3.Modelling with categorical variables
4.Autocorrelation

Related activities:
Activity A8

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Planning of activities

Activity A1: Descriptive statistics: sampling and measures of position and dispersion

Hours: 8h
Self study: 8h

Description:
Individual assignment - practical exercises

Support materials:
Minitab

Descriptions of the assignments due and their relation to the assessment:
The assignment must be handed in to the professor.
It forms part of continuous assessment

Specific objectives:
On completion of the activity, students must be able to:
1. Enter all kinds of data in the Minitab program.
2. Manipulate data: sort, filter, encode, operate with, etc.
3. Use the "Help" section in Minitab correctly.
4. Work with data files in Minitab.
5. Use the Minitab menus with ease.
6. Calculate statistical data values.

Activity A2: Graphic representation of data

Hours: 6h
Self study: 6h

Description:
Individual assignment - practical exercises

Support materials:
Minitab

Descriptions of the assignments due and their relation to the assessment:
The assignment must be handed in to the professor.
It forms part of continuous assessment.

Specific objectives:
On completion of the activity, students must be able to:
1.Recognise different types of data and make the appropriate graphics.
2.Make diagrams of points, polygons, frequencies, etc. and interpret them.
3.Make use of box diagrams and draw conclusions.

Activity A3: Linear and non-linear regression. Curve fitting

Hours: 12h
Self study: 12h

Description:
Individual assignment - practical exercises

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Support materials:
Minitab

Descriptions of the assignments due and their relation to the assessment:
The assignment must be handed in to the professor.
It forms part of continuous assessment.

Specific objectives:
1.Use the correct distribution for a problem involving random variables.
2.Calculate the table values of distributions, both manually (using tables) and using Minitab.
3.Work with normal distributions, which are the most commonly used distributions in statistics

Activity A4: Special distributions	Hours: 8h Self study: 8h

Description:
Individual assignment - practical exercises

Support materials:
Minitab

Descriptions of the assignments due and their relation to the assessment:
The assignment must be handed in to the professor.
It forms part of continuous assessment

Specific objectives:
On completion of the activity, students must be able to:
1.Use the correct distribution for a problem involving random variables.
2.Calculate the table values of distributions, both manually (using tables) and using Minitab.
3.Work with normal distributions, which are the most commonly used distributions in statistics.

Activity A5: Statistical inference: confidence intervals and hypothesis testing	Hours: 12h Self study: 12h

Description:
Individual assignment - practical exercises

Support materials:
Minitab

Descriptions of the assignments due and their relation to the assessment:
The assignment must be handed in to the professor.
It forms part of continuous assessment.

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Specific objectives:
On completion of the activity, students must be able to:
1.Calculate the confidence intervals of population means, variances and proportions, both manually and using Minitab.
2.Formulate a hypothesis test for a population mean, variance and proportion. Calculate it manually and using Minitab.
3.Formulate a hypothesis test for two population means, two population variances and two population proportions. Calculate it manually and using Minitab.
4.Draw conclusions from the results obtained.

Activity A6: Concepts in multivariate statistics

Hours: 12h
Self study: 12h

Description:
Individual assignment - practical exercises

Support materials:
Minitab

Descriptions of the assignments due and their relation to the assessment:
The assignment must be handed in to the professor.
It forms part of continuous assessment.

Specific objectives:
On completion of the activity, students must be able to:
1.Understand multivariate analysis techniques.
2.Recognise and formulate a multiple linear regression problem.
3.Draw conclusions from the results obtained for a multiple linear regression problem.
4.Use Minitab as a tool for formulating and solving multiple linear regression problems

Activity A7: Experimental design and analysis

Hours: 12h
Self study: 12h

Description:
Individual assignment - practical exercises

Support materials:
Minitab

Descriptions of the assignments due and their relation to the assessment:
The assignment must be handed in to the professor.
It forms part of continuous assessment.

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Specific objectives:
On completion of the activity, students must be able to:
1.Formulate single-factor experimental design problems.
2.Formulate simple factorial experimental design problems.
3.Formulate simple 2k experimental design problems.
4.Draw conclusions from the results obtained for an experimental design problem.
5.Use Minitab as a tool for formulating and solving experimental design problems.

Activity A8: Time series	Hours: 10h Self study: 10h

Description:
Individual assignment - practical exercises

Support materials:
Minitab

Descriptions of the assignments due and their relation to the assessment:
The assignment must be handed in to the professor.
It forms part of continuous assessment.

Specific objectives:
On completion of the activity, students must be able to:
1.Recognise and formulate a time series problem.
2.Carry out a time series decomposition.
3.Carry out a time series autocorrelation.
4.Draw conclusions from the results obtained using Minitab.

Qualification system

Face-to-face assessment system: The final mark takes into account the following:
1.Class attendance during the course.
2.Student participation and degree of involvement during the course.
3.Individual assignments that students must present and defend during the course. Marks for assignments have the most weight in the final mark.
In addition to the course materials, exercises to be solved must be regularly submitted by students via the ATENEA virtual campus (every two weeks, approximately). These exercises must be done using the Minitab statistics software (or an equivalent program). Summaries of the topics covered during the course are provided, as well as links to web pages that help students to understand and explore the topics in depth.

The final mark takes into account the following:
1. The submission and assessment of individual assignments carried out by students during the course.
2.At the end of the course, there are individual face-to-face sessions on the assignments submitted, in which students must demonstrate that they themselves have carried out the assignments and that they have understood and assimilated the topics.

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Regulations for carrying out activities

All the activities are compulsory.
If students do not carry out one of the activities for the subject they will be given a mark of 0.

Bibliography

Basic:

Walpole, Ronald E., i altres. Probabilidad y estadística para ingeniería y ciencias. 9ª ed. México: Pearson Educación, 2012. ISBN 9786073214179.

Ipiña, Santiago L.; Durand, Ana Isabel. Inferencia estadística y análisis de datos. Madrid: Pearson Educación, 2008. ISBN 9788483224045.

Polo Miranda, Carlos. Estadística multivariable [on line]. 4ª ed. Barcelona: Edicions UPC, 2005 [Consultation: 12/01/2018]. Available on: <http://hdl.handle.net/2099.3/36241>. ISBN 8483018152.

Montgomery, Douglas C. Design and analysis of experiments. 8th ed., international student version. New York: John Wiley & Sons, 2013. ISBN 9781118097939.

Box, George E. P.; Hunter, J. Stuart; Hunter, William Gordon. Estadística para investigadores: diseño, innovación y descubrimiento. 2ª ed. Barcelona: Reverté, 2008. ISBN 9788429150445.

Pepió Viñals, Montserrat. Series temporales [on line]. 2ª ed. Barcelona: Edicions UPC, 2002 [Consultation: 12/01/2018]. Available on: <http://hdl.handle.net/2099.3/36262>. ISBN 8483016362.

Others resources:

Computer material

Minitab

Resource