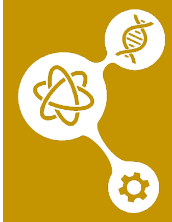
Course
2026/2027

Course Guide:

APPLIED STATISTICS



FACULTAD DE
CIENCIAS QUÍMICAS

1. IDENTIFICATION

Degree Programme	Bachelor's Degree in Chemical Engineering			Code	801532
Subject	Applied Statistics			ECTS	6
Field	Statistics				
Module	Core				
Type	Core	Year	First	Semester	Second
Responsible Department	Mathematical Analysis and Applied Mathematics				

Course Instructors

Group A

Activity	Lecturer	Email	Office
Tª/S/Tut.	GLORIA CABRERA GÓMEZ	cabrera@ucm.es	QB634 (Faculty of Chemistry); 712 (Faculty of Statistical Studies)

Group B

Activity	Profesor	Email	Despacho
Tª/ Tut.	UWE RICHARD OTTO BRAUER	oub@ucm.es	QB636 (Faculty of Chemistry)
S	MIGUEL FRANCISCO BAREA FERNÁNDEZ	mibarea@ucm.es	

2. OBJECTIVES

General Objective

For most students, this course marks their first encounter with statistics, and for all of them, their first with experimental design—a distinct, though no less rigorous, mode of scientific enquiry.

The general aim of this course is to equip students with the tools for handling data from a statistical standpoint and for the planning of experiments, whilst acquiring the knowledge specified in the syllabus. A sound mathematical foundation, such as that developed in *Mathematics I*.

Specific Objectives

- Familiarity with the basic techniques for handling datasets.
- Use of statistical distribution tables.
- Understanding of the elementary techniques of statistical inference, confidence intervals and hypothesis testing.
- Application of the ANOVA method.

- Use of statistical software.
- Understanding of experimental design tools.
- Application of optimisation techniques.

3. PREREQUISITES AND RECOMMENDATIONS

Prerequisites

The material covered by the official syllabuses of *Mathematics I* y *Mathematics II* in the Spanish baccalaureate, with particular attention to topics relating to statistics (Year 12).

The material covered by the official syllabus of *Mathematics I* in the first year of the Bachelor's Degree in Chemical Engineering.

Recommendations

Students lacking the prerequisites listed above are advised to acquire them before beginning the course.

Students are encouraged to attain a working knowledge of English sufficient to read bibliography in that language, conduct information searches and communicate in writing and orally.

4. COURSE CONTENT

Brief Description of Contents

Descriptive statistics. Probability. Independence of events and conditional probability. One-dimensional continuous and discrete random variables. Common distributions. The central limit theorem. Statistical inference: parametric estimation, hypothesis testing and analysis of variance. Design of experiments and optimisation.

Syllabus

1. Descriptive Statistics

1.1. Descriptive study of a single variable.
1.2 Joint study of two variables.
1.3 The regression line.
1.4 Probability.
1.5 Independence of events and conditional probability.

2. Probability Distributions.

2.1 Random variables. Distribution function.
2.2 Discrete variables. The binomial and Poisson distributions.
2.3 Continuous variables. Probability density.
2.4 The normal distribution. The central limit theorem.
2.5 Sampling distributions.

3. Statistical Inference.

3.1 Parametric inference. Maximum likelihood estimator.
3.2 Estimators and their probability distributions.
3.3 Confidence intervals.
3.4 Hypothesis testing.

4. Introduction to Experimental Design.

4.1 Single-factor experiments.
4.2 Analysis of variance.

4.3 Randomised block designs.

5. COMPETENCES

General

CG1	Apply concepts from foundational and technical subjects so as to learn new methods and theories independently and address novel situations.
CG5	Carry out calculations, measurements, assessments, expert analyses, studies and reports within the relevant field of knowledge.

Specific

CE1-E1	Analyse datasets both qualitatively and quantitatively
CE1-E2	Identify different types of random variables and calculate their expected value, standard deviation and other statistical parameters
CE1-E3	Calculate confidence intervals and conduct hypothesis tests.
CE1-E4	Apply the techniques of analysis of variance.
CE1-E5	Use experimental design tools and optimisation techniques.

Transversal

CT1	Demonstrate analytical and synthetic thinking.
CT6	Use software tools and computer programmes.
CT8	Demonstrate critical and self-critical reasoning.

6. WORKLOAD AND DISTRIBUTION BY ACTIVITY

Applied Statistics is a six-credit course taught throughout the second semester of the first year. In line with ECTS criteria, the total student workload amounts to 150 hours per year, distributed as follows:

Activity	Contact (hours)	Independent study (hours)	Credits
Lectures	30	50	3,2
Seminars	15	25	1,6
Tutorials/Directed work	3/1	4,5/1,5	0,3/0,1
Coursework and exam preparation	6	14	0,8
Total	**55**	**95**	**6**

7. TEACHING METHODOLOGY

Durante las **in-person lectures** the content of the course will be presented to students in accordance with the syllabus.

A set of problems and exercises will be posted on the virtual campus for students to attempt independently.

Some of the recommended reading and supporting materials uploaded to the virtual campus will be in English.

Los **seminars** are in-person practical classes.

Problem-solving sessions will be conducted in seminars.

In computer-lab seminars, students will solve statistical problems using software that they will have already become acquainted with in the Applied Computing course.

Directed Activities: practical exercises in the form of directed assignments will also be set, for which scheduled tutorials will be held.

Tutorial attendance: students will be organised into groups, each of which will attend four one-hour tutorials over the course of the year.

8. BIBLIOGRAPHY

Core Reading

- ÁLVAREZ CONTRERAS: "*Estadística Aplicada. Teoría y Problemas*", C.L.A.G.S.A., 2000. (1st Revised and Expanded Edition)
- PEÑA, D.: "*Regresión y diseño de Experimentos*", Alianza.

Further Reading

- CANAVOS: "*Probabilidad y Estadística. Aplicaciones y métodos*", McGraw Hill.
- SPIEGEL: "*Estadística*", McGraw Hill, 1991.
- ROSS, SHELDON M.: "*Introducción a la Estadística*", Reverté, 2005.
- PEÑA, D.: "*Estadística, Modelos y Métodos. Tomo 2*", Alianza.
- COCHRAN, W. G.; COX, G. M.: "*Diseños Experimentales*", Trillas, 1990.
- BOX, G. E.; HUNTER, J. S.; HUNTER, W. G.: "*Estadística para Investigadores*", Reverté.
- RODRÍGUEZ SALAZAR, S.: "*Matemáticas para estudiantes en Químicas*", Síntesis, 2007.
- STEINER, E.: "*Matemáticas para ciencias aplicadas*", Reverté, 2005.
- MONTGOMERY, D. C.: "*Diseño y Análisis de Experimentos*", Limusa Wiley.
- VICENTE, Mª L.: "*Diseño de Experimentos. Soluciones con SAS y SPSS*", Pearson

9. ASSESSMENT

Assessment consists of progress tests (continuous assessment) and a final examination.

- **PROGRESS TESTS: 30%**

  Two written progress tests will be held during the course, each accounting for 15% of the final mark.

- **FINAL EXAMINATION: 70%**

  A three-hour final examination will account for 70% of the mark.

  The final mark is obtained by combining the progress test scores with the final examination mark.

  Only where a student has passed both progress tests will the final mark be the higher of the weighted score (15% per test plus 70% for the final examination) and the final examination mark alone.

- **RESIT EXAMINATION: 100%**

  Students who fail the course are entitled to sit a three-hour resit examination, which constitutes 100% of the mark.

All competences will be assessed.

The marks for both progress tests will be communicated to students with sufficient notice before the final examination to allow for adequate study planning. In all cases they will be issued within a maximum of 20 days. For the second test, a shorter period may apply so as to align with the final examination schedule, subject always to a minimum of seven days between the publication of marks and the date of the final examination.

ACTIVITY SCHEDULE

TOPIC	ACTIVITY	HOURS	GROUPS	START	END
1. Descriptive Statistics	Lectures	4	1	Week 1	Week 2
	Problem Classes	2	1		
2. Probability Distributions	Lectures	8	1	Week 3	Week 6
	Problem Classes	4	1		
3. Statistical Inference	Lectures	10	1	Week 7	Week 11
	Problem Classes	4	1		
	Computer Lab Practicals	1	1		
4. Introduction to Experimental Design	Lectures	8	1	12th Week	Week 15
	Problem Classes	2	1		
	Computer Lab Practicals	2	1		
	Scheduled Tutorials*	3	2	To be confirmed	
	Directed Activities	1	2		
	Written Examinations	6	1	As set by the Faculty	

* Tutorial scheduling depends on the full course timetable.

SUMMARY OF TEACHING ACTIVITIES

TEACHING ACTIVITY	ASSOCIATED COMPETENCES	LECTURER ACTIVITY	STUDENT ACTIVITY	ASSESSMENT METHOD	P	NP	TOTAL	C
In-person Lectures	CG5, CE1, CE25 CT2, CT3	Presentation of the topics in the syllabus.	Listening. Understanding. Raising questions. Taking notes for subsequent queries.	Progress tests and final examination.	30	95		100%
In-person Practical Classes	CG5, CE1, CE25, CT2, CT3	Application of theory to exercises and problems.	Solving set problems. Raising questions and queries. Presenting solutions at the board.	Progress tests and final examination.	15			
Directed Activities	CE3, CT6	Supporting students in the use of statistical software.	Consulting the lecturer on conceptual and methodological difficulties encountered during study.	Attendance is compulsory on designated days.	1			
Tutorías	CG5, CE1, CE3, CE25, CT2, CT3, CT6	Guiding students in their independent study.	Consulting the lecturer on conceptual and methodological difficulties encountered during study.	Attendance is compulsory on designated days.	3			
Exámenes	CG5, CE1, CE3, CE25, CT2, CT3, CT6	Setting, invigilating and marking the examination. Grading students.	Preparation and sitting of examinations.	Progress tests and final examination.	6			

P: Contact activities

NP: Non-contact activities (independent study)

C: Calificación