



## Teaching Guide

Identifying Data				2022/23
Subject (*)	Numerical and Statistical Methods	Code	610G04013	
Study programme	Grao en Nanociencia e Nanotecnoloxía			
Descriptors				
Cycle	Period	Year	Type	Credits
Graduate	1st four-month period	Second	Obligatory	6
Language	Spanish			
Teaching method	Face-to-face			
Prerequisites				
Department	Matemáticas			
Coordinador	Ferreiro Ferreiro, Ana María	E-mail	ana.ferreiro@udc.es	
Lecturers	Ferreiro Ferreiro, Ana María López Cheda, Ana Vazquez Cendon, Carlos	E-mail	ana.ferreiro@udc.es ana.lopez.cheda@udc.es carlos.vazquez.cendon@udc.es	
Web	<a href="https://campusvirtual.udc.gal/">https://campusvirtual.udc.gal/</a>			
General description	This course aims to develop skills that allow students to develop critical knowledge of numerical and statistical methods.			

## Study programme competences / results

Code	Study programme competences / results
A3	CE3 - Reconocer y analizar problemas físicos, químicos, matemáticos, biológicos en el ámbito de la Nanociencia y Nanotecnología, así como plantear respuestas o trabajos adecuados para su resolución, incluyendo el uso de fuentes bibliográficas.
A7	CE7 - Interpretar los datos obtenidos mediante medidas experimentales y simulaciones, incluyendo el uso de herramientas informáticas, identificar su significado y relacionarlos con las teorías químicas, físicas o biológicas apropiadas.
B2	CB2 - Que los estudiantes sepan aplicar sus conocimientos a su trabajo o vocación de una forma profesional y posean las competencias que suelen demostrarse por medio de la elaboración y defensa de argumentos y la resolución de problemas dentro de su área de estudio
B4	CB4 - Que los estudiantes puedan transmitir información, ideas, problemas y soluciones a un público tanto especializado como no especializado
B5	CB5 - Que los estudiantes hayan desarrollado aquellas habilidades de aprendizaje necesarias para emprender estudios posteriores con un alto grado de autonomía
B6	CG1 - Aprender a aprender
B7	CG2 - Resolver problemas de forma efectiva.
B8	CG3 - Aplicar un pensamiento crítico, lógico y creativo.
B9	CG4 - Trabajar de forma autónoma con iniciativa.
B10	CG5 - Trabajar de forma colaborativa.
B11	CG6 - Comportarse con ética y responsabilidad social como ciudadano/a y como profesional.
B12	CG7 - Comunicarse de manera efectiva en un entorno de trabajo.
C3	CT3 - Utilizar las herramientas básicas de las tecnologías de la información y las comunicaciones (TIC) necesarias para el ejercicio de su profesión y para el aprendizaje a lo largo de su vida
C7	CT7 - Desarrollar la capacidad de trabajar en equipos interdisciplinarios o transdisciplinarios, para ofrecer propuestas que contribuyan a un desarrollo sostenible ambiental, económico, político y social.
C8	CT8 - Valorar la importancia que tiene la investigación, la innovación y el desarrollo tecnológico en el avance socioeconómico y cultural de la sociedad
C9	CT9 - Tener la capacidad de gestionar tiempos y recursos: desarrollar planes, priorizar actividades, identificar las críticas, establecer plazos y cumplirlos

## Learning outcomes



Learning outcomes	Study programme competences / results		
Identify the need for the use of numerical and statistical methods in solving models of real problems, especially originated in nanoscience and nanotechnology	A3 A7	B2 B4 B5 B7 B8 B9 B10	C7
Know and acquire fluency in the handling of numerical methods for the solution of different problems, as well as knowing the conditions to approximate the solution	A3 A7	B2 B4 B5 B6 B7 B8 B9 B10	
Have criteria to select the most efficient numerical methods in different problems, especially those related to nanoscience and nanotechnology	A3 A7	B2 B4 B5 B6 B7 B8 B9 B10 B11 B12	C7 C8
Acquire knowledge about probability and statistical methods of modeling, data analysis, diagnosis and interpretation of results	A3	B2 B4 B5 B6 B7 B8 B9 B10 B11 B12	C3 C7 C8 C9
Manage software tools that implement the studied methodology and know how to analyze the results	A3 A7	B2 B4 B5 B6 B7 B8 B9 B10 B11 B12	C3 C7



Topic	Sub-topic
Unit 0: Introduction to numerical methods	Introduction to numerical methods. Erros.
Unit 1: Numerical resolution of linear systems and numerical approximation fo eigenvalues	<ul style="list-style-type: none"> <li>- Direct methods (LU, Cholesky)</li> <li>- Iterative methods (Jacobi, Gauss-Seidel)</li> <li>- Aproximation of eigenvalues:: QR</li> <li>- Aplicacions</li> </ul>
Unit 2: Numerical resolution of non-linear equations	<ul style="list-style-type: none"> <li>- Non-linear equations (bisection, Newton and variant, functional iteration)</li> <li>- Non-linear systems (functional iteration, Newton)</li> <li>- Aplicacions</li> </ul>
Unit 3: Interpolation, numerical derivation and integration	<ul style="list-style-type: none"> <li>- Interpolation (Lagrange, Chebyshev, Splines)</li> <li>- Numerical derivation</li> <li>- Numerical integration (middle point, trapezoid, Simpson, gaussian quadrature)</li> <li>- Aplicacions</li> </ul>
Unit 4. Basic concepts on probability theory	<ul style="list-style-type: none"> <li>- Probability formulas</li> <li>- Conditional probability and independent events</li> <li>- Bayes' theorem</li> </ul>
Unit 5. Random variables	<ul style="list-style-type: none"> <li>- Discrete and continuous variables</li> <li>- Normal distribution and Central Limit Theorem</li> <li>- Applications in Nanoscience and Nanotechnology</li> </ul>
Unit 6. Introduction to Statistical Inference	<ul style="list-style-type: none"> <li>- Estimators and sampling distributions</li> <li>- Linear regression</li> <li>- Statistical analysis software tools</li> </ul>

Planning				
Methodologies / tests	Competencies / Results	Teaching hours (in-person & virtual)	Student?s personal work hours	Total hours
Guest lecture / keynote speech	A3 B2 B4 B5 B6 B7 B11 C8	28	56	84
Problem solving	A7 B8 B12	8	16	24
ICT practicals	A3 A7 B2 B4 B10 C3 C7 C9	12	25	37
Mixed objective/subjective test	B7 B9 C9	3	0	3
Personalized attention		2	0	2

(\*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies	
Methodologies	Description
Guest lecture / keynote speech	Exhibition of the contents specified in the program of the subject, for which audiovisual media or blackboard will be used.
Problem solving	Sessions where relevant problems in the field of Science and Engineering will be presented, which will be solved both analytically and numerically: the student must be able to reach the solution of any problem using pencil and paper or alternatively using computer tools, and compare the results.
ICT practicals	Interactive practices in which relevant problems in the field of Science and Engineering will be solved. In the part corresponding to Numerical Methods Units 0 - 3) we will programate in Python, and in the Statistical Methods part (Units 4-6) we will work with R using Rcmdr.
Mixed objective/subjective test	Development of issues and problems of the subject.

Personalized attention
------------------------



Methodologies	Description
ICT practicals Problem solving	<p>a) Due to the diversity of the students and their training, a personalized orientation is recommended, which could be carried out through tutorials.</p> <p>b) Practices with ICT tools in problem solving, or teachers will help students in the development of two stated problems, as well as applications to problems in the field of Science and Engineering.</p> <p>c) As specific personalized attention measures for the "Students with recognition of part-time dedication and academic waiver of attendance exemption" for the study of the subject, the continuous assessment of the practices through ICT and the resolution of problems will be carried out through tests you parted online.</p>

Assessment			
Methodologies	Competencies / Results	Description	Qualification
ICT practicals	A3 A7 B2 B4 B10 C3 C7 C9	Resolución de problemas de carácter práctico empregando o linguaxe de programación Python ou R.	30
Problem solving	A7 B8 B12	Resolución de problemas de carácter práctico.	20
Mixed objective/subjective test	B7 B9 C9	Proba que inclúe a resolución de cuestións e problemas da materia	50

Assessment comments
<p>The subject is organized in two parts: Numerical Methods (MNum) and Statistical Methods (MEst).</p> <p>The contents corresponding to part MNum are indicated in Units 0-3, and the contents corresponding to part MEst are indicated in Units 4-6. Each part will be qualified on 10 points:</p> <p>The qualification of MNum (CNum) will be between 0 and 10 points. The qualification of MEst (CEst) will be between 0 and 10 points. The final qualification of the subject will be the mean of the notes achieved in each of the two parts: <math>\text{Nota Final} = (\text{CNum} + \text{CEst})/2</math></p> <p>The qualification for each one of the two parts of the subject is the following:</p> <p>The MNum qualification is divided into three parts: Qualification of ITC practices (CP_1): between 0 and 3.5 points Qualification of problems resolution (CR_1): between 0 and 1.5 points Qualification of the mixed objective test (CE_1): between 0 and 5 points. The final qualification of MNum (CNUM) will be the sum of the three parts <math>\text{CP}_1 + \text{CR}_1 + \text{CE}_1</math>, if the qualification of the mixed objective test is greater than 1.5 (over 5 points). In another case, the final qualification will be the qualification obtained on the objective test, CE_1.</p> <p>The final qualification of the part will be: <math>\text{CNum} = \text{CP}_1 + \text{CR}_1 + \text{CE}_1</math></p> <p>The qualification of the part MEst is divided into three parts: Qualification of ITC practices (CP_2): between 0 and 2.5 points Qualification of problems resolution (CR_2): between 0 and 2.5 points Qualification of the mixed objective test (CE_2): between 0 and 5 points. The final qualification of MEst (CEst) will be the sum of the three parts <math>\text{CP}_2 + \text{CR}_2 + \text{CE}_2</math>, if the qualification of the mixed objective test is greater than 1.5 (over 5 points). In another case, the final qualification will be the qualification obtained on the objective test, CE_2.</p> <p>The final qualification of MEst will be: <math>\text{CEst} = \text{CP}_2 + \text{CR}_2 + \text{CE}_2</math></p> <p>The final qualification of the subject will be the mean of CNum and CEst: <math>\text{NotaFinal} = (\text{CEst} + \text{CNum})/2</math></p> <p>In the second opportunity of the evaluation: In the second opportunity, the student will only have to attend the part of the exam which he/she failed in the first opportunity: In the part of MNum, the grades related to the practices through ICT (CR_1) and problem solving (CP_1) will be kept. In the part of MEst, the grades related to the practices through (CR_2) and problem solving (CP_2) will be kept. A Non-Attended state will be assigned to those students who do not attend the final mixed test.</p> <p>-Observations on the "Students with recognition of part-time dedication and academic exemption from attendance exemption": The specific personalized attention measures for the "Students with recognition of part-time dedication and academic exemption from attendance exemption" for the study of subject, the continuous evaluation of the practices through TIC and of the resolution of problems will realize by means of partial proofs online.</p>

Sources of information
------------------------



<b>Basic</b>	<ul style="list-style-type: none"><li>- Steven C. Chapra, Raymond P. Canale (2019). Métodos Numéricos para ingenieros (7º ed). McGrawHill</li><li>- James F. Epperson (2021). An Introduction to Numerical Methods and Analysis (3rd Ed.). Wiley</li><li>- J. Douglas Faires, R. Burden (2014). Métodos Numéricos (7ª ed). Thomson</li><li>- R. Cao Abad y otros (2001). Introducción a la estadística y sus aplicaciones. Ed. Pirámide</li><li>- F. Rius Díaz, F.J. Barón López (2005). Bioestadística. Thomson.</li><li>- A.J. Arriaza Gómez (2008). Estadística básica con R y R-Commander. Servicio Publicaciones UCA.</li></ul>
<b>Complementary</b>	<ul style="list-style-type: none"><li>- Jeffrey J. Heys (2017). Chemical and Biomedical Engineering Calculations Using Python. Wiley</li><li>- Jaan Kiusalaas (2013). Numerical Methods in Engineering with Python 3. Cambridge University Press</li><li>- J. Baró Llinas, (1998). Estadística Descriptiva, Cálculo de probabilidades e Inferencia estadística (tres volúmenes). Ed. Parramón</li><li>- W. Navidi (2006). Estadística para ingenieros y científicos (1ª Ed) . Mc Graw-Hill</li></ul>

## Recommendations

### Subjects that it is recommended to have taken before

Physics: Electricity and Magnetism/610G04007

Fundamentals of Mathematics/610G04001

Advanced Calculus /610G04009

Physics: Mechanics and Waves/610G04002

Fundamentals of Computing Science/610G04010

### Subjects that are recommended to be taken simultaneously

### Subjects that continue the syllabus

Differential Equations/610G04016

### Other comments

Daily study of the contents treated in the classroom, complementing them with the recommended bibliography.

(\*)The teaching guide is the document in which the URV publishes the information about all its courses. It is a public document and cannot be modified. Only in exceptional cases can it be revised by the competent agent or duly revised so that it is in line with current legislation.