Teaching Guide				
Identifying Data				2024/25
Subject (*)	Numerical Methods for Data Science		Code	614G02033
Study programme	Grao en Ciencia e Enxeñaría de Datos			
Descriptors				
Cycle	Period	Year	Type	Credits
Graduate	1st four-month period	Fourth	Optional	6
Language	Spanish			
Teaching method	Face-to-face			
Prerequisites				
Department	Matemáticas			
Coordinador	Gonzalez Taboada, Maria	E-mail	maria.gonzalez.taboada@udc.es	
Lecturers	Gonzalez Taboada, Maria	E-mail	maria.gonzalez.taboada@udc.es	
Web	campusvirtual.udc.gal			
General description	In this subject students will learn numerical methods for solving nonlinear equations, large systems of linear and nonlinear equations, and to approximate eigenvalues of large matrices. They will also learn optimization methods for large dimension and interpolation techniques in one and several variables.			

Study programme competences / results	
Code	Study programme competences / results
A2	CE2 - Capacidade para resolver problemas matemáticos, planificando a súa resolución en función das ferramentas dispoñibles e das restricións de tempo e recursos.
B2	CB2 - Que os estudantes saiban aplicar os seus coñecementos ao seu traballo ou vocación dunha forma profesional e posúan as competencias que adoitan demostrarse por medio da elaboración e defensa de argumentos e a resolución de problemas dentro da súa área de estudo
B3	CB3 - Que os estudantes teñan a capacidade de reunir e interpretar datos relevantes (normalmente dentro da súa área de estudo) para emitir xuízos que inclúan unha reflexión sobre temas relevantes de índole social, científica ou ética
B4	CB4 - Que os estudantes poidan transmitir información, ideas, problemas e solucións a un público tanto especializado como non especializado
B7	CG2 - Elaborar adecuadamente e con certa orixinalidade composicións escritas ou argumentos motivados, redactar plans, proxectos de traballo, artigos científicos e formular hipóteses razoables.
B8	CG3 - Ser capaz de manter e estender formulacións teóricas fundadas para permitir a introdución e explotación de tecnoloxías novas e avanzadas no campo.
B9	CG4 - Capacidade para abordar con éxito todas as etapas dun proxecto de datos: exploración previa dos datos, preprocesado, análise, visualización e comunicación de resultados.
B10	CG5 - Ser capaz de traballar en equipo, especialmente de carácter multidisciplinar, e ser hábiles na xestión do tempo, persoas e toma de decisións.
C1	CT1 - Utilizar as ferramentas básicas das tecnoloxías da información e as comunicacións (TIC) necesarias para o exercicio da súa profesión e para a aprendizaxe ao longo da súa vida.
C4	CT4 - Valorar a importancia que ten a investigación, a innovación e o desenvolvemento tecnolóxico no avance socioeconómico e cultural da sociedade.

Learning outcomes	
Learning outcomes	Study programme competences / results

Identify the potential of numerical methods in the solution of problems from data science.	A2	B2 B3 B4 B8 B9	C1 C4
Understand the basis of numerical methods to be able to apply them with criteria, not being a mere user of the options of a software package as a black box.	A2	B2 B3 B4 B7 B8 B9	C1 C4
Be able to decide which numerical methods can be applied to solve each problem and which ones are the most efficient. Have the basis to learn more advanced methods.	A2	B2 B3 B4 B7 B8 B9	C1 C4
Manage software tools that implement the numerical methods studied and acquire the ability to implement them and make extensions.	A2	B2 B4 B9 B10	C1 C4

Contents	
Topic	**Sub-topic**
Basic concepts in numerical methods: convergence, errors and order.	
Numerical methods for nonlinear equations	Bisection, secant method, Regula Falsilla, fixed point method and Newton-Raphson
Numerical methods for the solution of large linear systems	Direct and iterative methods
Numerical methods for approximating eigenvalues and eigenvectors	Power methods. QR method.
Methods for storing large matrices in the computer	
Numerical methods for solving nonlinear systems of equations	Fixed point methods. Newton's method.
Numerical methods for optimization	Gradient and Conjugate gradient methods. Line-search methods. Newton and quasi-Newton methods. Global optimization methods and two-phase methods.
Numerical interpolation in one and several variables.	

Planning				
Methodologies / tests	**Competencies / Results**	**Teaching hours (in-person & virtual)**	**Student?s personal work hours**	**Total hours**
ICT practicals	A2 B2 B3 B4 B9 B10 C1 C4	14	35	49
Supervised projects	A2 B2 B3 B4 B7 B8 B9 B10 C1 C4	2	11	13
Problem solving	A2 B2 B4 B9 B10	7	14	21
Objective test	A2 B2 B3 B4 B7 B8 C1	2	4	6
Guest lecture / keynote speech	A2 B2 B3 B4 B8 B9	20	40	60
Personalized attention		1	0	1

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

Methodologies	
Methodologies	**Description**
ICT practicals	The teacher will help students deepen the concepts and numerical methods presented during the guest lectures using Python.
Supervised projects	Students will develop a supervised project in which they will combine the use of the different learning outcomes acquired in the subject.
Problem solving	Students will solve problems that help them to understand how the studied numerical methods work.
Objective test	There will be an exam on the dates decided by the Faculty Board. The exam will focus essentially on the solution of practical problems.
Guest lecture / keynote speech	During guest lectures, the teacher will present the different contents. She will motivate the need of the different numerical methods using real problems, and she will present the necessary concepts and different numerical methods, discussing their main features.

Personalized attention	
Methodologies	**Description**
ICT practicals Supervised projects Problem solving	During ICT practicals, the teacher will review and discuss with each student his/her advances in the assigned practice. In the supervised project, the teachers will discuss and review the advances of students as well as the final result. During problem-solving sessions, the teacher will solve students' questions on theoretical concepts and their practical applications. Finally, the teachers will solve the doubts raised by the students during their respective tutorial hours.

Assessment			
Methodologies	**Competencies / Results**	**Description**	**Qualification**
ICT practicals	A2 B2 B3 B4 B9 B10 C1 C4	Several practical small projects will be proposed and evaluated along the course.	30
Supervised projects	A2 B2 B3 B4 B7 B8 B9 B10 C1 C4	Teachers will propose a supervised project to each student that he/she will have to defend at the end of the subject.	20
Problem solving	A2 B2 B4 B9 B10	During the course there will be some small tests. They will consist on solving problems of the same type as those studied during the classes.	20
Objective test	A2 B2 B3 B4 B7 B8 C1	There will be a written exam on the dates set by the Faculty Board.	30

Assessment comments
In order to pass the subject, it is mandatory to attain at least a qualification of 50%. In the extraordinary call there will be an objective test. It will not be possible to recover the part of the final mark corresponding to continuous assessment. Part-time students and those with academic dispensation of attendance exemption that have not been evaluated of ICT practicals can do a specific exam to recover 70% of the final mark; they can obtain 30% of the final mark with the objective test. Fraudulent performance of the tests or evaluation activities, once verified, will directly imply a mark of "0" in the subject, invalidating any grade obtained in all the evaluation activities.

Sources of information

Basic	- R. Barrett, M. Berry, T.F. Chan, J. Demmel, J.M. Donato, J. Dongarra, V. Eijkhout, R. Pozo, C. Romin (1994). Templates for the Solution of Linear Systems: Building Blocks for Iterative Methods. SIAM - R.L. Burden, D.J. Faires & A.M. Burden (2017). Análisis Numérico. CENCAGE Learning - C.T: Kelley (2003). Solving Nonlinear Equations with Newton's Method. SIAM - S. Linge & H.P. Langtangen (2020). Programming for Computations - Python. Soringer - J. Nocedal & S.J. Wright (2006). Numerical Optimization. Springer - A. Quarteroni & F. Saleri (2006). Calculo cientifico con Matlab y Octave. . Springer
Complementary	- J.W. Demmel (1997). Applied Numerical Linear Algebra. SIAM - C.T. Kelley (1995). Iterative Methods for Linear and Nonlinear Equations. SIAM - C.T. Kelley (1999). Iterative Methods for Optimization. SIAM - D.R. Kincaid & E.W. Cheney (2022). Numerical Analysis: Mathematics of Scientific Computing. AMS - J Kiusalaas (2013). Numerical Methods in Engineering with Python 3. Cambridge University Press - M. Locatelli & F. Schoen (2013). Global Optimization. Theory, Algorithms and Applications. SIAM - G. Strang (2019). Linear Algebra and Learning from Data. Wellesley Cambridge Press

Recommendations
Subjects that it is recommended to have taken before
Linear Algebra/614G02001 Multivariable Calculus /614G02006 Fundamentals of Programming I/614G02004
Subjects that are recommended to be taken simultaneously
Subjects that continue the syllabus
Other comments
Students are recommended to take the subject up to date and consult with the teachers any doubts that may arise.