Teaching Guide				
Identifying Data				2023/24
Subject (*)	Differential Equations		Code	610G04016
Study programme	Grao en Nanociencia e Nanotecnoloxía			
Descriptors				
Cycle	Period	Year	Type	Credits
Graduate	2nd four-month period	Second	Obligatory	6
Language	Spanish			
Teaching method	Face-to-face			
Prerequisites				
Department	Matemáticas			
Coordinador	García Rodríguez, José Antonio	E-mail	jose.garcia.rodriguez@udc.es	
Lecturers	Ferreiro Ferreiro, Ana María García Rodríguez, José Antonio Otero Verea, Jose Luis	E-mail	ana.fferreiro@udc.es jose.garcia.rodriguez@udc.es luis.verea@udc.es	
Web	https://campusvirtual.udc.gal/login/index.php			
General description	This course aims to develop skills that allow students to develop knowledge of ordinary direffential equations and partial differential equations			

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 interdisciplinares o transdisciplinares, 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 different types of differential equations and problems associated with them. Especially those originating in nanoscience and nanotechnology	A3 A7	B2 B4 B6 B7 B8 B9	C3 C9
Know and acquire fluency in the techniques to obtain analytical and numerical solutions of models based on ordinary differential equations	A3 A7	B2 B4 B6 B7 B8 B9 B12	C7 C8 C9
Know and acquire fluency in the techniques to obtain analytical and numerical solutions of models based on partial differential equations	A3	B2 B5 B10 B11	C3 C7 C8 C9
Have criteria to choose the most efficient analytical and numerical techniques for models of real problems, especially those related to nanoscience and nanotechnology.	A3	B2 B4 B5 B6 B7 B8 B9 B10 B11 B12	C3 C7 C8 C9
Manage software tools that implement the methodologies studied and know how to analyze the results	A3 A7	B2 B4 B5 B6 B7 B9 B10 B12	C3 C9

Contents	
Topic	Sub-topic
Unit 1: First order ordinary differential equations	- Initial value problem - Analytic resolution - Mathematical models - Numerical resolution: Explicit Euler, Implicit Euler, Heun, Runge-Kutta. - Aplications

Unit 2: Systems of differential equations	- Systems of differential equations - Analytic resoluiton - Estability - Mathematical models - Numerical schemes: Explicit Euler, Implicit Euler, Heun, Runge-Kutta. - Applications
Unit 3: Second order ordinary differential equations	- Initial value problem. - Analytic resolution. Laplace transform, Fourier transform. - Mathematical models. - Numerical resoltion - Aplications - Contour problems - Analytic resolution. - Numerical resolution. Finite difference method. - Sturm-Liouville problems. Numerical approximation of eigenvalues and eigenfunctions - Aplications
Tema 4: Ecuacións en derivadas parciais.	- Ecuación de transporte. Resolución analítica mediante o método de características. Resolución numérica mediante el esquema de Godunov. - Ecuación do calor 1D. Resolución analítica mediante separación de variables. Resolución numérica por diferencias finitas. - Ecuación de ondas 1D. Resolución analítica mediante separación de variables. Resolución numérica por diferencias finitas. - Ecuación de Laplace e Poisson. Resolución analítica mediante separación de variables. Resolución numérica por diferencias finitas - Ecuación de calor 2D. Resolución analítica mediante separación de variables. Resolución numérica por diferencias finitas. - Ecuación de Schrödinger. Resolución analítica mediante separación de variables.. Resolución numérica por diferencias finitas. - Aplicacións

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
ICT practicals	A3 A7 B2 B4 B10 C3 C7 C9	12	26	38
Problem solving	A7 B8 B12	8	13	21
Mixed objective/subjective test	B7 B9 C9	3	0	3
Personalized attention		4	0	4
(*)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 (tablet) will be used.

ICT practicals	Interactive practices in which relevant problems in the field of Science and Engineering will be solved, using Python programming language.
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 (using Python), and compare the results.
Mixed objective/subjective test	Development of issues and problems of the subject.

Personalized attention	
Methodologies	**Description**
Problem solving ICT practicals	- The diversity of the students and their training make it advisable to have personalized guidance, which could be carried out through tutorials. - Practices with ITC tools in problem solving, or teachers will help students to develop two stated problems, as well as applications to problems in the field of Science and Engineering. - With the aim of preparing students for the different continuous assessment tests, as well as the final test; group defenses will be carried out, of the problems raised. Its realization will be set jointly between teachers and students. They will take place in the teachers' office. The defenses will be distributed in groups, in four sessions of 10 minutes (for each one of the groups). - The specific personalized attention measures for "Students with recognition of part-time dedication and academic waiver of attendance exemption" for the study of the subject, the continuous evaluation of the practices through ITC and the resolution of problems carried out attending, as far as possible, to your particular circumstances.

Assessment			
Methodologies	**Competencies / Results**	**Description**	**Qualification**
Mixed objective/subjective test	B7 B9 C9	Test that includes the resolution of questions and problems of the subject (by hand and/or Python)	50
Problem solving	A7 B8 B12	Rosolution of practical problems	25
ICT practicals	A3 A7 B2 B4 B10 C3 C7 C9	Resolution of practical problems using the Python programming language	25

Assessment comments

The final qualification of the subject consists of three parts:
Qualification of internships through ICT (CP): between 0 and 2.5 points Problem Solving Qualification (CR): between 0 and 2.5 points Mixed test qualification (CE): between 0 and 5 points.The final qualification will be the sum of three parts: Final_Note= CP + CR + CE, if the qualification of the mixed test (CE) is greater than 1.3 (over 5 points). In other case, the final qualification will be the mark obtained on the mixed test, CE.The qualification of the practices through ICT (CP) + the resolution of problems (CR), constitute the note of Continuous Evaluation (EV), EV = CP + CR. The qualifications of practices through ICT (CR) and problem solving (CP) will be kept on the second opportunity of the evaluation, that is, the EV note will be kept for the second opportunity.

The evaluation of CP + CR will be carried out by solving four small mixed tests, in which the student will have to solve problems of the subject by hand and with Python.
The qualifications of practices through ICT (CR) and problem solving (CP) will be retained in the second opportunity of the evaluation.
Students who do not show up for the final mixed test will be considered as "Not presented".
- Observations on o ?Students with recognition of part-time dedication and academic exemption from attendance exemption?: As specific personalized attention measures for o ?Students with recognition of part-time dedication and academic exemption from attendance exemption? for or study da matter, the continuous assessment of the practices through ICT and the resolution of problems carried out attending, as far as possible, to your particular circumstances.
- Observations on fraud: "During the performance of the practical test, on either occasion, except as otherwise indicated, the use of any device with Internet access is prohibited. If during the performance of the practical test, there are indications In case of unauthorized use of these devices, the student will be expelled from the classroom, and will proceed according to Law 3/2022, of February 24, on university coexistence and the disciplinary regulations of the UDC student body. Fraudulent completion of tests and/or activities will directly imply a failing grade ("0") in the subject in the corresponding call, invalidating any grade obtained in all activities for the next opportunity, if any, within the same academic course. It will be considered fraudulent to carry out activities, proposed to be completed in person in the classroom, that are done from outside the classroom, proceeding according to Law 3/2022, of February 24, on university coexistence and the disciplinary regulations of the UDC student "

Sources of information	
Basic	- Dennis G. Zill (2018). Ecuaciones diferenciales con problemas con valores en la frontera (9ª ed). Cengage - C. Henry Edwards, David E. Penney (2017). Ecuaciones diferenciales y problemas con valores en la frontera. Cómputo y modelado (4ª ed). Pearson Education - Wei-Chau Xie (2014). Differential Equations for Engineers (2º ed). Cambridge University Press - Richard G. Rice, Duong D. Do (2012). Applied Mathematics And Modeling For Chemical Engineers (2º ed). John Wiley & Sons - William E. Boyce, Richard C. DiPrima, Douglas B. Meade (2017). Elementary Differential Equations and Boundary Value Problems, (11ª Ed). Willey - Stephen Lynch (2018). Dynamical Systems with Applications using Python. Springer

Complementary	- Svein LingeHans, Petter Langtangen (2017). Programming for Computations - Python A Gentle Introduction to Numerical Simulations with Python. Springer // Github: https://github.com/hplgit - J. C. Butcher (2016). Numerical Methods for Ordinary Differential Equations, (3ª ed). Wiley - George F. Simmons (2016). Differential Equations with Applications and Historical Notes. Chapman and Hall/ - Steven C. Chapra , Raymond P. Canale (2015). Métodos Nméricos para Ingenieros (7ª ed). McGraw-Hill - William E. Boyce, Richard C. DiPrima, Douglas B. Meade (2017). Elementary Differential Equations and Boundary Value Problems, Student Solutions Manual, (11ª Ed). Wiley - Victor Henner, Alexander Nepmnyashchy, Tatyana Belozerova, Mikhain Khenner (2023). Ordinary Differential Equations. Analytical Methods and Applications. Springer

Recommendations
Subjects that it is recommended to have taken before
Numerical and Statistical Methods/610G04013 Fundamentals of Mathematics/610G04001 Advanced Calculus /610G04009 Fundamentals of Computing Science/610G04010
Subjects that are recommended to be taken simultaneously
Subjects that continue the syllabus
Other comments
It is recommended to have knowledge of the second year of high school. In particular, differential and integral calculus.Daily study of the contents treated in the classroom, complementing them with the recommended bibliography.Gender perspective: as stated in the transversal competences of the title (C4), the development of a critical, open and respectful citizenship with diversity in our society will me promoted, highlighting the equal rights of students without discrimination based on gender or sexual condition. An inclusive language will be used in the material and during the development of the lessons.