Teaching Guide				
Identifying Data				2023/24
Subject (*)	Advanced Calculus		Code	610G04009
Study programme	Grao en Nanociencia e Nanotecnoloxía			
Descriptors				
Cycle	Period	Year	Type	Credits
Graduate	2nd four-month period	First	Basic training	6
Language	SpanishGalician			
Teaching method	Face-to-face			
Prerequisites				
Department	Matemáticas			
Coordinador	Suarez Taboada, Maria	E-mail	maria.suarez3@udc.es	
Lecturers	López Salas, José Germán Suarez Taboada, Maria	E-mail	jose.lsalas@udc.es maria.suarez3@udc.es	
Web	https://campusvirtual.udc.gal/course/view.php?id=15383			
General description	This subject aims to the development of competencies that allow the student to critically understant differential and integral calculus with several variables.			

Study programme competences	
Code	Study programme competences
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

Conocer y manejar con soltura las funciones en varias variables escalares y vectoriales: su representación espacial, su necesidad en el modelado de problemas reales, el cálculo de límites y la continuidad	A3 A7	B2 B4 B5 B6 B7 B8 B9 B10 B11 B12	C3 C7 C8 C9
Conocer y manejar con soltura el cálculo diferencial en varias variables: derivadas parciales y direccionales, operadores diferenciales, desarrollo de Taylor y cálculo de extremos y extremos condicionados. Saber aplicar los conocimientos a problemas reales, especialmente relacionados con la titulación.	A3 A7	B2 B4 B5 B6 B7 B8 B9 B10 B11 B12	C3 C7 C8 C9
Conocer y adquirir soltura en las técnicas de integración en varias variables, aplicándolo a problemas reales.	A3 A7	B2 B4 B5 B6 B7 B8 B9 B10 B11 B12	C3 C7 C8 C9
Conocer y adquirir soltura en la integración sobre curvas y superficies. Saber aplicar las fórmulas de Green y Stokes, aplicándolo a problemas relacionados con la titulación	A3 A7	B2 B4 B5 B6 B7 B8 B9 B10 B11 B12	C3 C7 C8 C9
Manejar herramientas de software que implementen las metodologías estudiadas y saber analizar los resultados.	A3 A7	B2 B4 B5 B6 B7 B8 B9 B10 B11 B12	C3 C7 C8 C9

Contents	
Topic	**Sub-topic**
Unit 1: Topology in R^n	Scalar product, norm and distance. Classification of points and sets. Topology in R: bounded sets, supreme, infimo, maximum and minimum. Polar, cylindrical and spherical oordinates. Applications.
Unit 2: Functions of more than one variable	Scalar and vector functions. Level sets. Continuity. Applications.
Unit 3: Differentiation of functions of more than one variables and applications	Directional derivative. Partial derivatives: properties and practical computations. Differerential of a function. Relationship between the differential and the partial derivatives. Gradient vector, relationship with the directional derivatives. Jacobian matrix. Higher order partial derivatives. Introduction to vector calculus. Taylor's theorem for scalar functions. Critical points, classification. Hessian matrix. Extremos condicionados: reducción de la dimensión, método de los multiplicadores de Lagrange. Aplicaciones.
Unit 4: Integration of functions of one and more variables	Double integrals. Triples integrals. Change of variables in double and triple integrals. Applications of integrals.
Unit 5: Integration in curves and surfaces	Parameterized curves. Integral line. Gradient function and conservative field. Green's theorem. Parameterized surfaces. Integral of surface. Sotkes theorem. Divergence's theorem. Applications.

Planning				
Methodologies / tests	**Competencies**	**Ordinary class hours**	**Student?s personal work hours**	**Total hours**
Guest lecture / keynote speech	A3 A7 B6 B11 C8	28	56	84
ICT practicals	B2 B4 B5 B7 B12 C3 C7 C8	12	25	37
Mixed objective/subjective test	A3 B2 B6 B7 B9	3	0	3
Problem solving	B2 B4 B5 B7 B8 B9 B10 B12 C3 C7 C9	8	16	24
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 this, audiovisual media or blackboard will be used.
ICT practicals	Interactive practices in which relevant problems in the field of Science and Engineering will be solved, for this the Python programming language will be used
Mixed objective/subjective test	Development of issues and problems of the subject.
Problem solving	Sessions where relevant problems in the field of Sciences 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 by hand or alternatively using computer tools, and compare the results.

Personalized attention	
Methodologies	**Description**
Problem solving ICT practicals	a) During practical and solving problems lessons, professors will help students to develop purposed problems as well as applications to problems outside the scope of Science and Engineering. b) As specific personalized attention measures for "Students with partial time dedication recognition and academic exemption from attendance exemption" for the study of the subject, the continuous assessment of practical lessons through ICT and problem solving will be carried out through online tests. b)As medidas de atención personalizada específicas para o ?Alumnado con recoñecemento de dedicación a tempo parcial e dispensa académica de exención de asistencia? para o estudo da materia, a avaliación continua das prácticas a través de TIC e da resolución de problemas realizarase mediante probas parciais online.

Assessment			
Methodologies	**Competencies**	**Description**	**Qualification**
Problem solving	B2 B4 B5 B7 B8 B9 B10 B12 C3 C7 C9	Resolución de problemas de carácter práctico.	20
ICT practicals	B2 B4 B5 B7 B12 C3 C7 C8	Resolución de problemas de carácter práctico empregando o linguaxe de programación Python	20
Mixed objective/subjective test	A3 B2 B6 B7 B9	Proba que inclúe a resolución de cuestións e problemas da materia	60

Assessment comments

The final qualification of the subject consists of three parts:
Practical qualifications by ITC (CP): between 0 and 2 pointsSolving problems qualifications (CR): between 0 and 2 points
Objective test qualification (CE):

1.- If CP+CR is above or equal to 2 points, objective test qualification (CE) will be CE=10-(CP+CR). 2.- If CP+CR is below 2 points, objective test qualification (CE) will be CE=8-(CP+CR).The final qualification will be the sum of the three parts CP + CR + CE, if the qualification of the objective test is above 2 (over 10 points). In other situation, the final qualification will be the qualification of the objective test, CE.

The qualifications of the practical lessons by ITC (CR) and solving problems (CP) will be kept for the second opportunity of the assessment.

In the proceedings, the students who do not attend the final test will be considered as "Not presented".

During the assessment tests, on either occasion, except as otherwise indicated, the use of any device with Internet access is prohibited. If during the test, there are indications of the unauthorized use of these devices, the student will be expelled from the classroom, and the procedure will be carried out according to Law 3/2022, of February 24, on university coexistence and the disciplinary regulations of the students at the UDC.

The fraudulent performance of the tests and/or activities will directly imply the qualification of fail ("0") in the subject in the corresponding call, invalidating any qualification obtained in all the activities for the next opportunity, if any, within the same academic courses. It is considered fraudulent to carry out the 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 regulation of the UDC student body .

Sources of information	
Basic	Bibliografía:Jerrold Marsden. " Cálculo Vectorial". Pearson. Edición 6ª. 2018.Ron Larson, Bruce Edwards. "Cálculo. Tomo II". Cengage Learning, Edición 10ª.2018.Claudia Neuhauser, "Calculus for Biology and Medicine", Prentice Hall.Edición 2ª. 2004.Robert G. Mortimer. "Mathematics for Physical Chemistry". Pearson. Edición 4ª. 2013.Saturnino L. Salas, Finar Hille, Garret J. Etgen. "Calculus II. Una y varias varialbles" (Vol. nº 2). Reverté. Edición 4ª. 2018.Edward Jen Herman, Gilbert Strang. "Calculus. Volumen 3". OpenStax. Rice University. Disponible gratuitamente en :https://openstax.org/details/books/calculus-volume-3Bibliografía para prácticas a través de TIC:Jeffrey J. Heys. "Chemical and Biomedical Engineering Calculations using Python". Wiley. 2017.Svein Linge, Hans P. Langtangen. "Programming for Computations - Python. A Gentle Introduction to Numerical Simulations with Python". Springer. Texts in Computational Science and Engineering. Edición 1ª. 2017.Anders Mathe-Sorenssen."Elementary Mechanics Using Python: A Modern Course Combining Analytical and Numerical Techniques (Undergraduate Lecture Notes in Physics)". Springer. 2015.Robert Johansson. "Numerical Python: Scientific Computing and Data Science Applications with Numpy, Scipy and Matplotlib". Apress. . Edición: 2ª. 2018.Rubin H. Landau, Manuel J. Paez, Christian C. Bordeiany. "Computational Physics: Problem Solving with Computers". Wiley VCH Verlag GmbH. Edición 2ª. 2007.
Complementary	

Recommendations
Subjects that it is recommended to have taken before

Fundamentals of Mathematics/610G04001 Physics: Mechanics and Waves/610G04002
Subjects that are recommended to be taken simultaneously
Fundamentals of Computing Science/610G04010
Subjects that continue the syllabus
Numerical and Statistical Methods/610G04013 Differential Equations/610G04016
Other comments
It is recommended to have knowledge of the second year of high schoolDaily 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. Work will be done to identify and modify prejudices and sexist attitudes and influence the environment to modify them and promote values of respect and equality. Green Campus Program of the Faculty of Science In order to achieve an inmediate and sustainablem and to fullfill the point 6 of the "Declaración Ambiental da Facultade de Ciencias (2020)", the work carried out in this subject will be requested in virtual format or computer support.