



## Teaching Guide

Identifying Data					2024/25
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, María	E-mail	maria.suarez3@udc.es		
Lecturers	Suarez Taboada, María	E-mail	maria.suarez3@udc.es		
Web	<a href="https://campusvirtual.udc.gal/course/view.php?id=15383">https://campusvirtual.udc.gal/course/view.php?id=15383</a>				
General description	This subject aims to the development of competencies that allow the student to critically understand differential and integral calculus with several variables.				

## 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



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 $\mathbb{R}^n$	Scalar product, norm and distance. Classification of points and sets. Topology in $\mathbb{R}$ : 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 / Results	Teaching hours (in-person & virtual)	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
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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	<p>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.</p> <p>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.</p> <p>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.</p>

### Assessment

Methodologies	Competencies / Results	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 points Solving 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".

All these considerations will be applied for the extraordinary opportunity.

During the assessment tests, on either occasion, except as otherwise indicated, the use of any device with Internet access is prohibited.

All aspects related to "academic exemption", "dedication to study", "permanence" and "academic fraud" will be governed in accordance with the current academic regulations of the UDC.

### Sources of information

<b>Basic</b>	<p>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 variables" (Vol. nº 2). Reverté. Edición 4ª. 2018. Edward Jen Herman, Gilbert Strang. "Calculus. Volumen 3". OpenStax. Rice University. Disponible gratuitamente en : <a href="https://openstax.org/details/books/calculus-volume-3">https://openstax.org/details/books/calculus-volume-3</a> Bibliografía 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-Sorensen. "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.</p>
<b>Complementary</b>	

### 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 school. 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 be 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 immediate and sustainable and to fulfill 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.

**(\*)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.**