



## Teaching Guide

| Teaching Guide      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |                    |           |
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| Identifying Data    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |                    | 2020/21   |
| Subject (*)         | CÁLCULO                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        | Code               | 730G04001 |
| Study programme     | Grao en enxeñaría en Tecnoloxías Industriais                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |                    |           |
| Descriptors         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |                    |           |
| Cycle               | Period                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Year   | Type               | Credits   |
| Graduate            | 1st four-month period                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | First  | Basic training     | 6         |
| Language            | SpanishGalician                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |                    |           |
| Teaching method     | Hybrid                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |        |                    |           |
| Prerequisites       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |        |                    |           |
| Department          | Matemáticas                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |                    |           |
| Coordinador         | Campo Cabana, Marco Antonio                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | E-mail | marco.campo@udc.es |           |
| Lecturers           | Campo Cabana, Marco Antonio                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | E-mail | marco.campo@udc.es |           |
| Web                 | campusvirtual.udc.es/moodle                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |                    |           |
| General description | This introductory calculus course covers differentiation and integration of functions of one and several variables. Topics include: the study of functions of one and several variables, their continuity and diferenciability; Taylor polynomials and its application in optimization, finding local extrema and constrained optimization; the integration of functions in one variable, both by using Riemann sums and numerical integration and also using Barrow's rule, together with its applications to computing arc lengths, volumes of revolution and surface areas of revolution; and finally the integration of functions of several variables, together with its application to computing volume and mass of a solid body and its center of mass. |        |                    |           |



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|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Contingency plan</b> | <p>1. Modifications to the contents</p> <p>No changes will be made.</p> <p>2. Methodologies</p> <p>*Teaching methodologies that are maintained</p> <ul style="list-style-type: none"><li>- Master classes</li><li>- Exercises resolution</li><li>- Mixed tests</li></ul> <p>*Teaching methodologies that are modified</p> <p>3. Mechanisms for personalized attention to students</p> <ul style="list-style-type: none"><li>- Email: Daily. To make consultations and request virtual meetings to solve doubts.</li></ul> <p>? Moodle: Daily. According to the needs of the students.</p> <p>? Teams: weekly session in a large group to advance the theoretical content in the time slot assigned to the subject in the school's classroom calendar. 1 weekly session in medium groups oriented to a more personal follow-up in the resolution of exercises of the thematic block that is being developed in the theoretical sessions.</p> <p>4. Modifications in the evaluation</p> <p>No changes will be made.</p> <p>*Evaluation observations:</p> <p>Students with recognition of dedication to part time and academic exemption, as is established in the "NORMA QUE REGULA O RÉXIME DE DEDICACIÓN AO ESTUDO DOS ESTUDANTES DE GRAO NA UDC (Arts. 2.3; 3.b e 4.5)(29/5/212), will be evaluated in the same conditions as the rest of the students.</p> <p>2.Requirements to pass the subject</p> <ul style="list-style-type: none"><li>1. Obtain a score equal to or greater than 5 points in the overall evaluation.</li><li>2. Obtain a minimum of 1.75 points out of 5 in each of the two blocks in which the subject is divided.</li><li>3. The July opportunity will be evaluated the same criteria as the June opportunity.</li></ul> <p>5. Modifications to the bibliography or webgraphy</p> <p>No changes will be made.</p> |
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| Code | Study programme competences                                                                                                                                                                                                                                                                                                                        |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A1   | FB1 Capacidade para a resolución dos problemas matemáticos que poidan formularse na enxeñaría. Aptitude para aplicar os coñecementos sobre: álgebra lineal; xeometría; xeometría diferencial; cálculo diferencial e integral; ecuacións diferenciais e en derivadas parciais; métodos numéricos; algorítmica numérica; estatística e optimización. |
| B1   | CB1 Que os estudantes demostren posuír e comprender coñecementos nunha área de estudo que parte da base da educación secundaria xeral e adoita encontrarse a un nivel que, aínda que se apoia en libros de texto avanzados, inclúe tamén algúns aspectos que implican coñecementos procedentes da vangarda do seu campo de estudo                  |
| 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 emitiren xuízos que inclúan unha reflexión sobre temas relevantes de índole social, científica ou ética                                                                                                          |
| B5   | CB5 Que os estudantes desenvolvan aquelas habilidades de aprendizaxe necesarias para emprenderen estudos posteriores cun alto grao de autonomía                                                                                                                                                                                                    |
| B7   | B5 Ser capaz de realizar unha análise crítica, avaliación e síntese de ideas novas e complexas                                                                                                                                                                                                                                                     |
| C1   | C3 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   | C6 Valorar criticamente o coñecemento, a tecnoloxía e a información dispoñible para resolver os problemas cos que deben enfrontarse.                                                                                                                                                                                                               |
| C5   | C7 Asumir como profesional e cidadán a importancia da aprendizaxe ao longo da vida.                                                                                                                                                                                                                                                                |

| Learning outcomes                                                                                                           |  |                             |                            |
|-----------------------------------------------------------------------------------------------------------------------------|--|-----------------------------|----------------------------|
| Learning outcomes                                                                                                           |  | Study programme competences |                            |
| Abilities in differential and integral calculus.                                                                            |  | A1                          | B1<br>B2<br>B3<br>B5<br>B7 |
| Being able to solve mathematical problems with applications in engineering. Abilities in geometry and differential geometry |  | A1                          | B1<br>B2<br>B3<br>B5<br>B7 |

| Contents                       |                                                                                                                                                                                                                                             |
|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Topic                          | Sub-topic                                                                                                                                                                                                                                   |
| The space $\mathbb{R}^n$       | The vector space $\mathbb{R}^n$ .<br>Scalar product: norms and distances.<br>Classification of points and sets.<br>Topology of $\mathbb{R}^n$ : bounded set, extrema.<br>Coordinates systems: polar, cylindrical and spherical coordinates. |
| Functions of several variables | Scalar and vector functions.<br>Level sets.<br>Continuity.<br>Continuity in compact sets.                                                                                                                                                   |



|                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|--------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Differentiation of functions of several variables and applications | <p>Directional derivative.</p> <p>Partial derivatives: properties and practical computing.</p> <p>Differential map of a function.</p> <p>Gradient, relation with partial derivatives.</p> <p>Relation between the differential map and partial derivatives: jacobian matrix.</p> <p>Higher order partial derivatives.</p> <p>Introduction to vector calculus.</p> <p>Taylor theorem for scalar functions.</p> <p>Critical points. Classification.</p> <p>Hessian matrix.</p> <p>Conditioned extremes: dimension reduction, Lagrange multipliers method.</p> <p>Implicit function theorem and inverse function theorem.</p> |
| Integration of functions of one and several variables              | <p>Riemann sums.</p> <p>Integrable functions.</p> <p>Integral Calculus Theorems: Mean Value Theorem, Fundamental Theorem and Barrow's rule.</p> <p>Primitive Calculus.</p> <p>Polynomial interpolation.</p> <p>Numerical integration. Compound Simpson's Rule.</p> <p>Application of integral calculus to computing arc lengths, volumes of revolution and surface areas of revolution.</p> <p>Double integrals.</p> <p>Triple integrals.</p> <p>Variable change in double and triple integrals.</p> <p>Application of integrals: calculation of areas and volumes.</p>                                                    |
| Complex numbers                                                    | <p>The field of complex numbers.</p> <p>Operations: sum, product.</p> <p>Module and argument.</p> <p>Polar form.</p> <p>Operating in polar form.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

| Planning                                                                                                                        |                            |                      |                               |             |
|---------------------------------------------------------------------------------------------------------------------------------|----------------------------|----------------------|-------------------------------|-------------|
| Methodologies / tests                                                                                                           | Competencies               | Ordinary class hours | Student's personal work hours | Total hours |
| Guest lecture / keynote speech                                                                                                  | A1 B2 B3 B5 B7 C4 C5       | 30                   | 45                            | 75          |
| Problem solving                                                                                                                 | A1 B1 B2 B3 B5 B7 C4 C5    | 26                   | 39                            | 65          |
| Mixed objective/subjective test                                                                                                 | A1 B1 B2 B3 B5 B7 C1 C4 C5 | 6                    | 0                             | 6           |
| 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 | The course will be developed during the regular classes where the professor will explain the main concepts and results of the subject. |
| Problem solving                | This classes are organized in such a way that we practice how to solve the proposed problems.                                          |



|                                 |                                                                                                                                                                                                                                                    |
|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Mixed objective/subjective test | Three exams will be carried out during the course. The first one will be a partial exam where only some of the chapters will be considered. A final exam will be done at the end of the semester. Furthermore a computer exam will be carried out. |
|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

## Personalized attention

| Methodologies   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Problem solving | <p>The contents of the course as well as the methodologies require that students work partly in an autonomous way. This may generate some questions that they can solve by using office hours as scheduled. In addition, homework will be guided by the lecturers of the course.</p> <p>Students with recognition of part-time dedication and academic exemption from attendance may use office hours as a reference in order to follow the course and be advised on autonomous work.</p> |

## Assessment

| Methodologies                   | Competencies                  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Qualification |
|---------------------------------|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| Problem solving                 | A1 B1 B2 B3 B5 B7<br>C4 C5    | After the completion of a thematic block, small collections of representative exercises will be proposed for evaluation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 20            |
| Mixed objective/subjective test | A1 B1 B2 B3 B5 B7<br>C1 C4 C5 | <p>These consist on written exams to assess the knowledge of the course by the students. The exams will be divided into 2 parts and the final qualification will be the addition of the qualification obtained in each of them.</p> <p>1) The first one will be done during the teaching period by means of a partial exam. It will likely involve contents of chapters 1, 2, 3 and 4. Students passing this exam, will not need to repeat the corresponding questions in the final exams. Otherwise, this part will be recoverable in the final exams.</p> <p>2) The final exam will be carried out in the period of final exams. It will include contents of the second part of the subject and a second chance to pass the first part.</p> <p>In case of passing any of these two parts, either in the partial or in the final exam of january, the qualification is retained for the present course until the exam of the second opportunity.</p> | 80            |

## Assessment comments

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|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Students with recognition of part-time dedication and academic exemption from attendance will be graded under the same conditions than other students, as explained above. |
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## Sources of information



|                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Basic</b>         | <ul style="list-style-type: none"> <li>- Salas, L., Hille, E., Etgen, G. (2003). Calculus. vol I-II. Madrid. Reverté</li> <li>- García, A. et al. (2007). Cálculo II. Teoría y Problemas de Análisis Matemático en Varias Variables. Madrid. Clagsa</li> <li>- García Castro, F., Gutiérrez Gómez, A. (1990-1992). Cálculo Infinitesimal. I-1,2. Pirámide. Madrid</li> <li>- Marsden, J., Tromba, A. (2010). Cálculo vectorial. ADDISON WESLEY</li> <li>- Spiegel, M. R. (1991). Cálculo Superior. Madrid. McGraw-Hill</li> <li>- Varios (1990). Problemas de Cálculo Infinitesimal. Madrid. R.A.E.C.</li> <li>- De Diego, B. (1991). Ejercicios de Análisis: Cálculo diferencial e intergral (primer curso de escuelas técnicas superiores y facultades de ciencias). Madrid. Deimos</li> <li>- Tébar Flores, E. (1977). Cálculo Infinitesimal. I-II. Madrid. Tébar Flores</li> <li>- García, A. et al. (2007). Cálculo I. Teoría y Problemas de Análisis Matemático en Una Variable. Madrid. Clagsa</li> <li>- Larson, R., Hostetler, R., Edwards, B. (2013). Calculus. . Brooks Cole</li> <li>- Coquillat, F (1997). Cálculo Integral. Madrid. Tebar Flores</li> <li>- Soler, M., Bronte, R., Marchante, L. (1992). Cálculo infinitesimal e integral. Madrid</li> <li>- Burgos Román, Juan de (2007). Cálculo infinitesimal de una variable. Madrid. McGraw-Hill</li> </ul> |
| <b>Complementary</b> | <p>As seguintes páxinas web poden resultar de interese para o estudo da materia: <a href="http://www.intmath.com">www.intmath.com</a><br/> <a href="http://www.ies.co.jp/math/java/">www.ies.co.jp/math/java/</a> <a href="http://demonstrations.wolfram.com/http://dm.udc.es/elearning/">http://demonstrations.wolfram.com/http://dm.udc.es/elearning/</a> <a href="http://www.intmath.com">www.intmath.com</a><br/> <a href="http://www.ies.co.jp/math/java/">www.ies.co.jp/math/java/</a> <a href="http://193.146.36.49/mat1">http://193.146.36.49/mat1</a></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

## Recommendations

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

### Subjects that are recommended to be taken simultaneously

### Subjects that continue the syllabus

Linear Algebra/730G03006

Statistics/730G03008

Differential Equations/730G03011

Reliability Statistics and Numerical Methods/730G03046

### Other comments

In order to get a sustainable neighbourhood and attain the aim of action number 5: "Docencia e investigación saudábel e sustentábel ambiental e social" of the "Plan de Acción Green Campus Ferrol", the homework of this course will attend to the following:

- Preferably, virtual homework will be used, when printing is not required.
- In the case that paper is needed, then:
- No plastic materials will be used.
- Printing will be done both sides.
- Recycled paper will be used as possible.

In general, a sustainable use of natural resources will be done. Moreover, ethic principles related to sustainability will be followed.

(\*)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.