

Escuela Técnica Superior de Ingenieros de Caminos, Canales y Puertos

## GUÍA DOCENTE DE LA ASIGNATURA

G2007 - Calculus

Grado en Ingeniería Civil

Arquitectura, construcción, edificación y urbanismo, e ingeniería civil  
Básica. Curso 1

Grado en Ingeniería Civil

Arquitectura, construcción, edificación y urbanismo, e ingeniería civil  
Básica. Curso 1

Programa Cornell

Obligatoria. Curso 1

Curso Académico 2023-2024

### 1. DATOS IDENTIFICATIVOS

|                           |  |                      |                      |                                    |
|---------------------------|--|----------------------|----------------------|------------------------------------|
| Título/s                  | Grado en Ingeniería Civil<br>Grado en Ingeniería Civil<br>Programa Cornell   |                      | Tipología<br>v Curso | Básica. Curso 1<br>Básica. Curso 1 |
| Centro                    | Escuela Técnica Superior de Ingenieros de Caminos, Canales y Puertos   |                      |                      |                                    |
| Módulo / materia          | FORMACIÓN BÁSICA<br>MATEMÁTICAS BÁSICAS PARA LA INGENIERÍA   |                      |                      |                                    |
| Código<br>y denominación  | G2007 - Calculus   |                      |                      |                                    |
| Créditos ECTS             | 6  | Cuatrimestre         | Cuatrimestral (1)    |                                    |
| Ámbito de<br>conocimiento | Arquitectura, construcción, edificación y urbanismo, e ingeniería civil<br>Arquitectura, construcción, edificación y urbanismo, e ingeniería civil |                      |                      |                                    |
| Web                       |  |                      |                      |                                    |
| Idioma<br>de impartición  | Inglés   | Forma de impartición | Presencial           |                                    |

|                         |  |  |  |  |
|-------------------------|--|--|--|--|
| Departamento            | DPTO. MATEMATICA APLICADA Y CIENCIAS DE LA COMPUTACION                           |  |  |  |
| Profesor<br>responsable | JOAQUIN BEDIA JIMENEZ  |  |  |  |
| E-mail                  | joaquin.bedia@unican.es  |  |  |  |
| Número despacho         | E.T.S. de Ingenieros de Caminos, Canales y Puertos. Planta: + 1. DESPACHO (1047) |  |  |  |
| Otros profesores        |  |  |  |  |

### 2. CONOCIMIENTOS PREVIOS

The previous knowledge required will be that acquired during high school, for which an adequate training in mathematics is assumed. It is recommended a profile of scientific-technical high schools or a higher degree training in engineering and/or technology.

### 3. RESULTADOS DEL PROCESO DE FORMACIÓN Y APRENDIZAJE

### 4. OBJETIVOS

In the Civil Engineering syllabus, the Calculus course serves as an introduction to essential mathematical tools that students will utilize throughout their studies. The objectives include developing proficiency in mathematical language and reasoning, cultivating intellectual work habits, understanding the modeling potential of calculus, gaining operational skills in manipulating mathematical functions and their properties, comprehending and applying differential and integral calculus in single and multiple variables to physics and engineering problems, familiarizing with relevant software and programming tools for problem-solving, and instilling a commitment to independent and collaborative study.

| 5. ACTIVIDADES ACADÉMICAS                     |                        |
|---|------------------------|
| ACTIVIDADES                                   | HORAS DE LA ASIGNATURA |
| <b>ACTIVIDADES PRESENCIALES</b>               |                        |
| HORAS DE CLASE (A)                            |                        |
| - Teoría (TE)                                 | 30                     |
| - Prácticas en Aula (PA)                      | 24                     |
| - Prácticas de Laboratorio Experimental (PLE) |                        |
| - Prácticas de Laboratorio en Ordenador (PLO) | 6                      |
| - Prácticas Clínicas (CL)                     |                        |
| Subtotal horas de clase                       | 60                     |
| <b>ACTIVIDADES DE SEGUIMIENTO (B)</b>         |                        |
| - Tutorías (TU)                               | 8                      |
| - Evaluación (EV)                             | 8                      |
| Subtotal actividades de seguimiento           | 16                     |
| <b>Total actividades presenciales (A+B)</b>   | <b>76</b>              |
| <b>ACTIVIDADES NO PRESENCIALES</b>            |                        |
| Trabajo en grupo (TG)                         | 10                     |
| Trabajo autónomo (TA)                         | 64                     |
| Tutorías No Presenciales (TU-NP)              |                        |
| Evaluación No Presencial (EV-NP)              |                        |
| <b>Total actividades no presenciales</b>      | <b>74</b>              |
| <b>HORAS TOTALES</b>                          | <b>150</b>             |

| 6. PROGRAMA DE LA ASIGNATURA |   |       |       |      |      |      |      |      |      |       |           |           |        |
|------------------------------|---|-------|-------|------|------|------|------|------|------|-------|-----------|-----------|--------|
| CONTENIDOS                   |   | TE    | PA    | PLE  | PLO  | CL   | TU   | EV   | TG   | TA    | TU-<br>NP | EV-<br>NP | Semana |
| 1                            | <p>BLOCK I: REAL AND COMPLEX NUMBERS, SEQUENCES, AND NUMERICAL SERIES. REAL UNIVARIATE FUNCTIONS.</p> <p>UNIT 1: REAL AND COMPLEX NUMBERS, NUMERICAL SEQUENCES, SERIES, AND POWER SERIES.</p> <p>1.1. Real numbers: Axiomatics of real numbers.</p> <p>1.2. Geometric representation and key concepts of the real line.</p> <p>1.3. Complex numbers: Definition.</p> <p>1.4. Geometric representation of complex numbers.</p> <p>1.5. Operations with complex numbers.</p> <p>1.6. Numerical sequences and series: Definitions.</p> <p>1.7. Convergence criteria for numerical series.</p> <p>UNIT 2: REAL UNIVARIATE FUNCTIONS.</p> <p>2.1. Concept and definitions of functions. Operations with functions.</p> <p>2.2. Elementary functions.</p> <p>2.3. Properties of even and odd functions, periodicity, symmetry, and dimension.</p> <p>2.4. Limit of a function at a point: Definition and properties.</p> <p>2.5. Indeterminate forms.</p> <p>2.6. Continuous function at a point and within an interval: Types of discontinuities.</p> <p>2.7. Theorems about continuous functions.</p> <p>2.8. Properties of differentiable functions at a point and within an interval.</p> <p>2.9. Rolle's and Mean Value Theorems.</p> <p>2.10. Application of the derivative to the calculation of limits: L'Hôpital's rule.</p> <p>2.11. Representation of functions as power series: Taylor and Mac-Laurin formulas. Local approximation of functions.</p> | 14,00 | 12,00 | 0,00 | 2,00 | 0,00 | 2,00 | 3,00 | 2,00 | 18,00 | 0,00      | 0,00      | 1-6    |
| 2                            | <p>BLOCK II: INTEGRAL CALCULUS OF FUNCTIONS OF ONE VARIABLE</p> <p>UNIT 3: INTEGRAL CALCULUS</p> <p>3.1. Calculation of primitives: Definitions and properties.</p> <p>3.2. Integration methods.</p> <p>3.3. Riemann integral: Interpretation and properties.</p> <p>3.4. Mean value theorem, Fundamental Theorem of Calculus, and Barrow's rule.</p> <p>3.5. Improper integrals.</p> <p>3.6. Parameterization of curves and polar coordinates.</p> <p>3.7. Applications of integrals: Calculation of planar areas, volumes of revolution, surfaces of revolution, and lengths of curves in Cartesian, parametric, and polar coordinates.</p>   | 8,00  | 6,00  | 0,00 | 2,00 | 0,00 | 3,00 | 3,00 | 4,00 | 22,00 | 0,00      | 0,00      | 7-10   |

|   |  |              |              |             |             |             |             |             |              |              |             |             |       |
|---|--|--------------|--------------|-------------|-------------|-------------|-------------|-------------|--------------|--------------|-------------|-------------|-------|
| 3   | BLOCK III. MULTIVARIATE REAL FUNCTIONS   | 8,00         | 6,00         | 0,00        | 2,00        | 0,00        | 3,00        | 2,00        | 4,00         | 24,00        | 0,00        | 0,00        | 11-15 |
|   | UNIT 4. MULTIVARIATE SCALAR AND VECTOR-VALUED FUNCTIONS  |              |              |             |             |             |             |             |              |              |             |             |       |
|   | 4.1. First notions about multivariate functions  |              |              |             |             |             |             |             |              |              |             |             |       |
|   | 4.2. Limits of scalar functions  |              |              |             |             |             |             |             |              |              |             |             |       |
|   | 4.3. Limits of vector-valued functions   |              |              |             |             |             |             |             |              |              |             |             |       |
|   | 4.4. Continuity of multivariate functions  |              |              |             |             |             |             |             |              |              |             |             |       |
|   | 4.5. Partial derivatives. Introduction. Definition. geometric interpretation.                      |              |              |             |             |             |             |             |              |              |             |             |       |
|   | 4.6. Continuity and partial derivatives. Partial derivatives of higher orders                      |              |              |             |             |             |             |             |              |              |             |             |       |
|   | 4.7. Differential. Differentiability and continuity. Sufficient condition for differentiability.   |              |              |             |             |             |             |             |              |              |             |             |       |
|   | 4.8. Gradient. Definition. Gradient vector and directional derivative. Gradient and contour lines. |              |              |             |             |             |             |             |              |              |             |             |       |
|   | 4.9. Extremes. Optimization. Lagrange multipliers.   |              |              |             |             |             |             |             |              |              |             |             |       |
| <b>TOTAL DE HORAS</b>                         |  | <b>30,00</b> | <b>24,00</b> | <b>0,00</b> | <b>6,00</b> | <b>0,00</b> | <b>8,00</b> | <b>8,00</b> | <b>10,00</b> | <b>64,00</b> | <b>0,00</b> | <b>0,00</b> |       |
| Esta organización tiene carácter orientativo. |  |              |              |             |             |             |             |             |              |              |             |             |       |

|       |  |
|-------|--|
| TE    | Horas de teoría                                |
| PA    | Horas de prácticas en aula                     |
| PLE   | Horas de prácticas de laboratorio experimental |
| PLO   | Horas de prácticas de laboratorio en ordenador |
| CL    | Horas de prácticas clínicas                    |
| TU    | Horas de tutoría                               |
| EV    | Horas de evaluación                            |
| TG    | Horas de trabajo en grupo                      |
| TA    | Horas de trabajo autónomo                      |
| TU-NP | Tutorías No Presenciales                       |
| EV-NP | Evaluación No Presencial                       |

| 7. SISTEMAS DE EVALUACIÓN DEL APRENDIZAJE |  |             |          |       |
|---|--|-------------|----------|-------|
| Descripción                               | Tipología  | Eval. Final | Recuper. | %     |
| Lab practice reports                      | Evaluación en laboratorio  | No          | No       | 12,00 |
| Calif. mínima                             | 0,00   |             |          |       |
| Duración                                  | 2 hours x 2 sessions   |             |          |       |
| Fecha realización                         | To be determined throughout the course   |             |          |       |
| Condiciones recuperación                  |  |             |          |       |
| Observaciones                             | The evaluation will be conducted through lab reports completed in pairs or small groups during the lab sessions. Students will work independently, following the provided practice script for each session. Prior preparation using the available examples on Moodle is necessary. The lab session will involve problem-solving related to theory using specific software and the development of a report presenting and discussing the results. The reports will adhere to a template provided by the instructor. Attendance at the sessions is mandatory for evaluation. The final grade for this activity will be the average of the individual marks obtained in each lab session throughout the course. |             |          |       |
| Continuous assessment                     | Otros  | No          | No       | 28,00 |
| Calif. mínima                             | 0,00   |             |          |       |
| Duración                                  | Exercises and activities of variable duration  |             |          |       |
| Fecha realización                         | To be determined, regularly throughout the course  |             |          |       |
| Condiciones recuperación                  |  |             |          |       |
| Observaciones                             | Brief exercises or assessment activities, lasting approximately 15-20 minutes, will be assigned on a regular basis throughout the semester. These exercises can be completed individually or in small groups and aim to review or further explore previously taught content. Around 6-8 exercises will be assigned in total. The final grade for this activity will be the average of all the grades obtained from these exercises throughout the course.  |             |          |       |
| Partial examination of Block I            | Examen escrito   | No          | Sí       | 15,00 |
| Calif. mínima                             | 0,00   |             |          |       |
| Duración                                  | 90 minutes   |             |          |       |
| Fecha realización                         | Around week 7  |             |          |       |
| Condiciones recuperación                  | Opportunity to resit during the Final Exam   |             |          |       |
| Observaciones                             | Individual assessment of contents of Block 1   |             |          |       |
| Partial examination of Block II           | Examen escrito   | No          | Sí       | 15,00 |
| Calif. mínima                             | 0,00   |             |          |       |
| Duración                                  | 90 minutes   |             |          |       |
| Fecha realización                         | Around week 14   |             |          |       |
| Condiciones recuperación                  | Opportunity to resit during the Final Exam   |             |          |       |
| Observaciones                             | Individual assessment of contents of Block 2   |             |          |       |
| Partial Examination of Block III          | Examen escrito   | Sí          | Sí       | 30,00 |
| Calif. mínima                             | 3,00   |             |          |       |
| Duración                                  | 90 minutes   |             |          |       |
| Fecha realización                         | According to official schedule   |             |          |       |
| Condiciones recuperación                  | Resit opportunity during the extraordinary call  |             |          |       |

|  |   |
|--|---|
| Observaciones  | The individual written test will assess the skills acquired during Block III. Additionally, it will provide an opportunity to resit previous partial examinations 1 and 2 in case of failure. If the previous partial examinations have been passed, only the last part of the test will be required, covering the contents after the second partial examination and avoiding any repetition of topics. |
| <b>TOTAL</b>   | <b>100,00</b>   |
| <b>Observaciones</b>   |   |
| <p>The final grade for the extraordinary assessment will be determined by the weighted average of various evaluation components outlined in the course's teaching guide. Students attending the extraordinary assessment will take a comprehensive exam, accounting for 60% of the final grade, covering the entire course syllabus, irrespective of prior approval of individual parts during regular evaluation.</p> <p>Failure to adhere to prescribed test formats (e.g., report templates, designated answer spaces in written exams) will result in penalties. Additionally, the following actions will be penalized:</p> <ul style="list-style-type: none"> <li>Unjustified answers.</li> <li>Inappropriate use of terminology and mathematical notation.</li> <li>Untidy work, excessive corrections, etc.</li> <li>Frequent spelling/grammar errors.</li> <li>Demonstrating a lack of fundamental mathematical skills in procedures.</li> </ul> <p>In exceptional cases supported by valid justifications (e.g., health restrictions), remote completion of assessment tests may be permitted with prior authorization from the Academic Authority.</p> |   |
| <b>Criterios de evaluación para estudiantes a tiempo parcial</b>   |   |
| <p>The course is accessible through the University of Cantabria Moodle platform. Part-time students are required to meet the same evaluation criteria as full-time students. However, in their case, the continuous assessment tasks assigned throughout the course may be completed individually and submitted in electronic format. Additionally, part-time students have the option, exclusive to them, to take a single written exam covering the material from all three thematic blocks. This single exam carries a weight of 60% towards the final grade and will be administered on the scheduled final exam date.</p>   |   |

## 8. BIBLIOGRAFÍA Y MATERIALES DIDÁCTICOS

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|---|
| <b>BÁSICA</b>   |
| Larson, L. y Edwards, B. H. Cálculo I y II. 9ª ed. Mc Graw Hill. ISBN: 978-970-10-5710-0.<br><a href="http://catalogo.unican.es/cgi-bin/abnetopac/?TITN=263113">http://catalogo.unican.es/cgi-bin/abnetopac/?TITN=263113</a> .<br>See also electronic book version: <a href="https://catalogo.unican.es/cgi-bin/abnetopac/O7448/IDd1bea231/NT1">https://catalogo.unican.es/cgi-bin/abnetopac/O7448/IDd1bea231/NT1</a> |
| Electronic material available in Moodle (exercises, slides, videos, software scripts etc.)  |
| <b>Complementaria</b>   |
| Marsden, J.E & Tromba, A.J. Cálculo Vectorial. Quinta edición. Pearson, Addison - Wesley, 2004. ISBN: 84-7829-069-9 / 978-84-7829-069-7. <a href="http://catalogo.unican.es/cgi-bin/abnetopac/?TITN=220433">http://catalogo.unican.es/cgi-bin/abnetopac/?TITN=220433</a>  |
| Apostol, T., Calculus. Vols. 1, 2 Ed. Reverté, 1991. ISBN: 84-291-5001-3.<br><a href="http://catalogo.unican.es/cgi-bin/abnetopac/?TITN=7199">http://catalogo.unican.es/cgi-bin/abnetopac/?TITN=7199</a>  |

## 9. SOFTWARE

| PROGRAMA / APLICACIÓN  | CENTRO                               | PLANTA | SALA | HORARIO |
|--|--------------------------------------|--------|------|---------|
| Maxima ( <a href="https://maxima.sourceforge.io/">https://maxima.sourceforge.io/</a> ) | ETSI Caminos<br>Canales y<br>Puertos |        |      |         |

### 10. COMPETENCIAS LINGÜÍSTICAS

- Comprensión escrita
- Comprensión oral
- Expresión escrita
- Expresión oral
- Asignatura íntegramente desarrollada en inglés

**Observaciones**