



## Teaching Guide

| Teaching Guide      |                                                                                                                                                                                                                                      |        |                         |           |
|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|-------------------------|-----------|
| Identifying Data    |                                                                                                                                                                                                                                      |        |                         | 2019/20   |
| Subject (*)         | Álgebra lineal II                                                                                                                                                                                                                    |        | Code                    | 632G02008 |
| Study programme     | Grao en Tecnoloxía da Enxeñaría Civil                                                                                                                                                                                                |        |                         |           |
| Descriptors         |                                                                                                                                                                                                                                      |        |                         |           |
| Cycle               | Period                                                                                                                                                                                                                               | Year   | Type                    | Credits   |
| Graduate            | 2nd four-month period                                                                                                                                                                                                                | First  | Basic training          | 6         |
| Language            | Spanish                                                                                                                                                                                                                              |        |                         |           |
| Teaching method     | Face-to-face                                                                                                                                                                                                                         |        |                         |           |
| Prerequisites       |                                                                                                                                                                                                                                      |        |                         |           |
| Department          | Matemáticas                                                                                                                                                                                                                          |        |                         |           |
| Coordinador         | Fuentes Garcia, Luis                                                                                                                                                                                                                 | E-mail | luis.fuentes@udc.es     |           |
| Lecturers           | Dominguez Perez, Xabier E.                                                                                                                                                                                                           | E-mail | xabier.dominguez@udc.es |           |
|                     | Fuentes Garcia, Luis                                                                                                                                                                                                                 |        | luis.fuentes@udc.es     |           |
|                     | Taboada Vazquez, Raquel                                                                                                                                                                                                              |        | raquel.taboada@udc.es   |           |
| Web                 | caminos.udc.es/info/asignaturas/grado_tecic/101/AL2/index.html                                                                                                                                                                       |        |                         |           |
| General description | The aim of the course is to provide a solid background in linear algebra and mathematical foundation engineering. This second part of the course focuses on studying the geometrical applications of the theory of vectorial spaces. |        |                         |           |

## Study programme competences

| Code | Study programme competences                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A1   | Capacidad para plantear y resolver los problemas matemáticos que puedan plantearse en el ejercicio de la profesión. En particular, conocer, entender y utilizar la notación matemática, así como los conceptos y técnicas del álgebra y del cálculo infinitesimal, los métodos analíticos que permiten la resolución de ecuaciones diferenciales ordinarias y en derivadas parciales, la geometría diferencial clásica y la teoría de campos, para su aplicación en la resolución de problemas de Ingeniería Civil. |
| B1   | Que los estudiantes hayan demostrado poseer y comprender conocimientos en un área de estudio que parte de la base de la educación secundaria general, y se suele encontrar a un nivel que, si bien se apoya en libros de texto avanzados, incluye también algunos aspectos que implican conocimientos procedentes de la vanguardia de su campo de estudio                                                                                                                                                           |
| B2   | 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                                                                                                                                                                                                                                                 |
| B3   | Que los estudiantes tengan la capacidad de reunir e interpretar datos relevantes (normalmente dentro de su área de estudio) para emitir juicios que incluyan una reflexión sobre temas relevantes de índole social, científica o ética                                                                                                                                                                                                                                                                              |
| B4   | Que los estudiantes puedan transmitir información, ideas, problemas y soluciones a un público tanto especializado como no especializado                                                                                                                                                                                                                                                                                                                                                                             |
| B5   | Que los estudiantes hayan desarrollado aquellas habilidades de aprendizaje necesarias para emprender estudios posteriores con un alto grado de autonomía                                                                                                                                                                                                                                                                                                                                                            |
| B6   | Resolver problemas de forma efectiva.                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| B7   | Aplicar un pensamiento crítico, lógico y creativo.                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| B8   | Trabajar de forma colaborativa.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| B10  | Comunicarse de manera efectiva en un entorno de trabajo.                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| B15  | Claridad en la formulación de hipótesis.                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| B16  | Capacidad de autoaprendizaje mediante la inquietud por buscar y adquirir nuevos conocimientos, potenciando el uso de las nuevas tecnologías de la información y así poder enfrentarse adecuadamente a situaciones nuevas.                                                                                                                                                                                                                                                                                           |
| B17  | Capacidad para aumentar la calidad en el diseño gráfico de las presentaciones de trabajos.                                                                                                                                                                                                                                                                                                                                                                                                                          |
| B18  | Capacidad para aplicar conocimientos básicos en el aprendizaje de conocimientos tecnológicos y en su puesta en práctica.                                                                                                                                                                                                                                                                                                                                                                                            |
| B19  | Capacidad de realizar pruebas, ensayos y experimentos, analizando, sintetizando e interpretando los resultados.                                                                                                                                                                                                                                                                                                                                                                                                     |
| C1   | Expresarse correctamente, tanto de forma oral como por escrito, en las lenguas oficiales de la comunidad autónoma.                                                                                                                                                                                                                                                                                                                                                                                                  |
| C2   | Dominar la expresión y la comprensión de forma oral e escrita de un idioma extranjero.                                                                                                                                                                                                                                                                                                                                                                                                                              |
| C3   | 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 la vida.                                                                                                                                                                                                                                                                                                                         |



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| C4 | Desarrollarse para el ejercicio de una ciudadanía abierta, culta, crítica, comprometida, democrática y solidaria, capaz de analizar la realidad, diagnosticar problemas, formular e implantar soluciones basadas en el conocimiento y orientadas al bien común. |
| C6 | Valorar críticamente el conocimiento, la tecnología y la información disponible para resolver los problemas con que deben enfrentarse.                                                                                                                          |
| C7 | Asumir como profesional y ciudadano la importancia del aprendizaje a lo largo de la vida.                                                                                                                                                                       |
| C8 | Valorar la importancia que tiene la investigación, la innovación y el desarrollo tecnológico en el avance socioeconómico y cultural de la sociedad.                                                                                                             |

| Learning outcomes                                                                                                                                    |  |                             |                                          |
|------------------------------------------------------------------------------------------------------------------------------------------------------|--|-----------------------------|------------------------------------------|
| Learning outcomes                                                                                                                                    |  | Study programme competences |                                          |
| To know and to understand the basic theory of linear algebra required in civil engineering , especially the geometric applications of vector spaces. |  | A1                          | B1<br>B6<br>B7<br>B8<br>B15              |
| Know, understand and manage elementary mathematical notation.                                                                                        |  | A1                          | B1<br>B3<br>B5<br>B6<br>B7<br>B18        |
| Learn to express with precision and rigor.                                                                                                           |  | A1                          | B4<br>B7<br>B10<br>B17                   |
| Learn to use the basic techniques of mathematical reasoning.                                                                                         |  | A1                          | B2<br>B3<br>B6<br>B7                     |
| Understanding the importance of justifying the thesis and results in science                                                                         |  | A1                          | B1<br>B3<br>B16<br>B19                   |
| Develop critical thinking and analytical skills .                                                                                                    |  | A1                          | B2<br>B3<br>B7                           |
| Learn to pose and solve mathematical problems of Linear Algebra.                                                                                     |  | A1                          | B2<br>B3<br>B6<br>B7<br>B8<br>B10<br>B15 |

| Contents |           |
|----------|-----------|
| Topic    | Sub-topic |



|                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|---------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Bilinear maps and homogenous tensors. | <ol style="list-style-type: none"><li>1. Bilinear maps and quadratic forms.<ol style="list-style-type: none"><li>1.1 Bilinear maps.</li><li>1.2 Bilinear forms.</li><li>1.3 Quadratic forms.</li><li>1.4 Real quadratic forms.</li></ol></li><li>2. Homogenous tensors and duality.<ol style="list-style-type: none"><li>2.1 Duality.</li><li>2.2 Homogenous tensor.</li><li>2.3 Operations with homogenous tensors.</li><li>2.4 Simmetry and skewsimmetry.</li></ol></li></ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Euclidean vectorial spaces.           | <ol style="list-style-type: none"><li>1. Introduction to euclidean spaces.<ol style="list-style-type: none"><li>1.1 Scalar product.</li><li>1.2 Norm of a vector. Properties.</li><li>1.3 Angle between two vectors.</li></ol></li><li>2. Orthogonality.<ol style="list-style-type: none"><li>2.1 Orthogonal vectors.</li><li>2.2 Orthogonal systems. Gram-Schmidt method.</li><li>2.3 Singularties of orthonormal basis.</li><li>2.4 Orthogonal projection.</li><li>2.5 Symmetric endomorphisms.</li></ol></li><li>3. Orthogonal maps.<ol style="list-style-type: none"><li>3.1 Definition.</li><li>3.2 Properties.</li><li>3.3 Eigenvalues and eigenvectors of an orthogonal map.</li><li>3.4 Orientation of a basis</li><li>3.5 Inverse and direct orthogonal maps.</li><li>3.6 Classiication of orthogonal maps in two and three dimensions.</li></ol></li><li>4. Vectorial product and triple product.<ol style="list-style-type: none"><li>4.1 Definition.</li><li>4.2 Properties.</li></ol></li></ol> |
| Affine geometry.                      | <ol style="list-style-type: none"><li>1. Affine space.<ol style="list-style-type: none"><li>1.1 Definition and properties.</li><li>1.2 System of reference.</li><li>1.3 Affine varieties.</li><li>1.4 Pencils of affine varieties.</li><li>1.5 Distances and angles between affine varieties.</li><li>1.6 Affine transformations.</li></ol></li><li>2. Projective space.<ol style="list-style-type: none"><li>2.1 Introduction.</li><li>2.2 Homogeneous coordinates.</li><li>2.3 Proper points and points at infinity.</li><li>2.4 Reference change in homogeneous coordinates.</li><li>2.5 Equations of affine varieties in homogeneous coordinates.</li></ol></li></ol>                                                                                                                                                                                                                                                                                                                                    |



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| Conics and quadric surfaces. | <p>1. Conics.</p> <p>1.1 Definition and equations.</p> <p>1.2 Intersections of a conic and a line.</p> <p>1.3 Polarity.</p> <p>1.4 Important potins and lines of a conic.</p> <p>1.5 Description of nondegenerated conics: ellipse, parabola e hyperbola.</p> <p>1.6 Change of reference.</p> <p>1.7 Classification of conics. Reduced equation.</p> <p>1.8. Pencils of conics.</p> <p>2. Quadric surfaces.</p> <p>2.1 Definition and equations.</p> <p>2.2 Intersections of a quadric surface and a line.</p> <p>2.3 Polarity.</p> <p>2.4 Change of reference.</p> <p>2.5 Important potins, lines and planes of a quadric surface.</p> <p>2.6 Classification of quadric surfaces. Reduced equation.</p> <p>2.7 Description of quadric surfaces of rank 3 and 4.</p> |
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| Planning                                                                                                                        |              |                      |                               |             |
|---------------------------------------------------------------------------------------------------------------------------------|--------------|----------------------|-------------------------------|-------------|
| Methodologies / tests                                                                                                           | Competencies | Ordinary class hours | Student?s personal work hours | Total hours |
| Guest lecture / keynote speech                                                                                                  | A1 B2 B3 C1  | 27                   | 32                            | 59          |
| Seminar                                                                                                                         | A1 B2 B3     | 27                   | 33                            | 60          |
| Mixed objective/subjective test                                                                                                 | A1 B2 B3     | 3                    | 3                             | 6           |
| Workbook                                                                                                                        | A1 B2 B3     | 0                    | 10                            | 10          |
| Problem solving                                                                                                                 | A1 B2 B3     | 0                    | 10                            | 10          |
| Personalized attention                                                                                                          |              | 5                    | 0                             | 5           |
| (*)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  | <p>New mathematic concepts will be developed from examples familiar for the students, or explaining the questions are wished to be solved with them; from this their common caracters will be abstracted causing its more accuracy deffinition. The theory which allows to solve the questions described at the beginning will be developed after.</p> <p>Students participation is desirable, sharing their doubts or comments as the class progresses.</p> |
| Seminar                         | <p>Simultaneously to the theoretical development of the matter collections of exercics are given.</p> <p>The goal is allowing students to practise the knowledge adquierd at theoretical classes.</p> <p>At seminars the most important problems will be discussed.</p>                                                                                                                                                                                      |
| Mixed objective/subjective test | Exam where concepts are methods of the subjets are evaluated.                                                                                                                                                                                                                                                                                                                                                                                                |
| Workbook                        | <p>Before the beginning of each item, some notes about the contents are available for the students. The notes are intended as a complement of teacher's explanations.</p> <p>A previous reading of students familiarize them with an outline of what they will study.</p>                                                                                                                                                                                    |
| Problem solving                 | Each student must solve individually some of the proposed problems.                                                                                                                                                                                                                                                                                                                                                                                          |



## Personalized attention

| Methodologies                                                   | Description                                                                                                     |
|-----------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| Problem solving<br>Guest lecture /<br>keynote speech<br>Seminar | We recommend using tutorials to ask any question regarding the subject, both theoretical and practical aspects. |

## Assessment

| Methodologies                         | Competencies | Description                                                         | Qualification |
|---------------------------------------|--------------|---------------------------------------------------------------------|---------------|
| Problem solving                       | A1 B2 B3     | Each student must solve individually some of the proposed problems. | 20            |
| Mixed<br>objective/subjective<br>test | A1 B2 B3     | Exam where concepts are methods of the subjects are evaluated.      | 80            |
| Others                                |              |                                                                     |               |

## Assessment comments

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## Sources of information

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|----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Basic</b>         | <ul style="list-style-type: none"> <li>- Juan de Burgos (2000). Álgebra Lineal. McGraw-Hill</li> <li>- Fuentes, Salete y Cruces (1980). Álgebra vectorial y Tensorial. ETSICCP Madrid</li> <li>- F. Granero (1992). Álgebra y Geometría Analítica. McGraw-Hill</li> <li>- Luis Fuentes García (2005-). Apuntes y ejemplos (<a href="http://caminos.udc.es/info/assignaturas/101/index.html">http://caminos.udc.es/info/assignaturas/101/index.html</a>). A Coruña</li> <li>- A. de la Villa (1994). Problemas de Álgebra. CLAGSA</li> <li>- Anzola, Caruncho y Pérez-Canales (1981). Problemas de Álgebra (Tomos 6,7). Madrid</li> </ul> |
| <b>Complementary</b> | <ul style="list-style-type: none"> <li>- S.I. Grossman (1995). Álgebra lineal. McGraw-Hill</li> <li>- J. Rojo (2001). Álgebra lineal. McGraw-Hill</li> <li>- M. Castellet e I. Llerena (1991). Álgebra lineal y geometría. Reverté</li> <li>- J. Rojo e I. Martín (1994). Ejercicios y problemas de álgebra. McGraw-Hill</li> <li>- M. García Galludo y otros (1984). Problemas de álgebra y analítica. Madrid</li> <li>- F. González Posada (1971). Problemas de estructuras algebraicas tensoriales. Madrid</li> </ul>                                                                                                                 |

## Recommendations

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

Cálculo infinitesimal I/632G02001

Álgebra lineal I/632G02007

### Subjects that are recommended to be taken simultaneously

Cálculo infinitesimal II/632G02002

### Subjects that continue the syllabus

Fundamentos de mecánica computacional/632G02015

Ecuacións diferenciais/632G02017

### Other comments

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(\*)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.