

COURSE DESCRIPTION – ACADEMIC YEAR 2023/2024

| Course title | Linear Algebra | | |
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| Course code | 42402 | | |
| Scientific sector | MAT/02 | | |
| Degree | Bachelor in Electronics and Cyberphysical Systems (L-8) | | |
| Semester | 1 | | |
| Year | 1 | | |
| Credits | 9 | | |
| Modular | No | | |
| Total lecturing hours | 60 | | |
| Total exercise hours | 30 | | |
| Attendance | Recommended | | |
| Prerequisites | Precalculus | | |
| Course page | Teams | | |
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| Specific educational objectives | The course belongs to the area of core fundamental sciences, specifically to the sector of mathematics, informatics and statistics. It is a mandatory course. It aims at providing students with general scientific contents and method characteristic of (1) Linear algebra of vectors and matrices. (2) Analytical geometry of tridimensional space, with vector methods. (3) Complex algebra and equations. The knowledge of these topics is a prerequisite for several other courses, especially Physics, Mathematical Analysis II, Electrotechnics | | |
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| Lecturers | Prof. Giovanni Modanese and Dr. Laura Levaggi | | |
| Contact | Prof. Modanese: | | |
| | Building K, Room 1.13 - e-mail: <u>Giovanni.Modanese@unibz.it - tel.</u> | | |

| Lecturers | Prof. Giovanni Modanese and Dr. Laura Levaggi | | | |
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| | Dr. Levaggi: | | | |
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| | 0471 017131 | | | |
| Scientific sector of lecturer | Prof. Modanese: MAT/07 – Dr. Levaggi: MAT/05 | | | |
| Teaching language | English | | | |
| Office hours | By apppointment via e-mail. | | | |
| Lecturing assistant (if any) | | | | |
| Contact LA | | | | |
| Office hours LA | | | | |
| List of topics | • Vector spaces: operations in V_0^2 , V_0^3 and their properties. | | | |
| | Vector space axioms. Linear combination. Basis. Spaces \mathbf{R}^2 , \mathbf{R}^3 , \mathbf{R}^n . Canonical basis. Isomorphism of a general n-dimensional vector space with \mathbf{R}^n . Scalar product and norm in \mathbf{R}^n . | | | |
| | • Matrices. Definitions and operations. Vector space structure. Basis in $M_{m,n}(\mathbf{R})$. Product. Inverse matrix, transpose matrix and their properties. | | | |



| Linear systems. Matrix form, homogeneous case. Dimension of the solution space, Gauss triangulation method. Linear dependence and independence of vectors. |
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| • Determinant and rank . Recursive definition, Laplace rule, properties. Computation of inverse matrices. Rank of a matrix: definition through determinants and linearly independent vectors. |
| • Linear transformations . Matrix representation. Nucleus. Isometries in R ² : rotations, axial symmetries. Orthogonal matrices. Homothetic and affine transformations. Definition and computation of eigenvalues and eigenvectors of a linear transformation. |
| • Geometry of space. Vector product, mixed product: geometrical definition, computation in components, properties. Plane analytical geometry: bundles of straight lines, distance point-to-line. Cartesian equation of a plan in space. Cartesian and parametric equation of a straight line in space. Nonintersecting lines. Distance plane-to-point. Distance between planes, distance between non-intersecting lines. |
| • Complex numbers. Definitions, computational rules, real and imaginary part, conjugate. Properties and operations in the complex field. Complex division. The Gauss plane. Trigonometric form of complex numbers. Operations in trigonometric form. Nroots of complex numbers, computed through the trigonometric form. Equations in a complex variable. |
| • General definition of linear operators. Matrix decompositions. Representation of linear operators in different bases. Matrices for the change of basis. Quadratic forms and their diagonalization. LU and QR decomposition and their applications; Gram-Schmidt orthogonalization method (both also with the use of a software). |

Frontal lectures, exercises

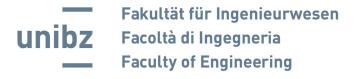
Learning outcomes

Teaching format

- 1. **Knowledge and understanding** of concepts, symbolism and techniques of linear algebra, analytical geometry of space, complex algebra.
- 2. Applying knowledge and understanding in solving exercises and problems which require a formalization, tools and methods learned in the course (for example, by solving linear systems, determining the rank and inverse of a matrix, decide whether some vectors are linearly independent, finding the Cartesian and parametric equations of straight lines and planes in space, solving an algebraic equation in the complex field).
- 3. **Making judgments** in tackling with the right approach and convenient tools problems and questions suitable to be formulated mathematically.
- 4. **Communication skills** in reporting on the calculations in a clear and effective way. This is also essential for the student to



| | be able to check his/her own results and overcome deadlocks in the resolution procedure. 5. Learning skills through the acquisition and assimilation of a symbolism, methods and tools which are necessary to understand the content of a consistent part of the courses in this academic curriculum. | | | |
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| Assessment | Written exam, consisting in 8-10 exercises containing various specific questions. Summative assessment | | | |
| | Form | % | Length /duration | ILOs |
| | Written exam | 100 | 3 hours | assessed 1-5 |
| | on the following 1. The student exactly in the 2. The student result, thus a course issues 3. The student final result, th being evident 4. The clarity ar evaluation of Altogether, the w allows to assess the sections are miss | points: must un e contex must so pplying s. must de hus prov ced by t nd comp commu vay in wi the learn ether the | derstand the questions at of the theory explained live the exercises and arrive the knowledge and under scribe the calculations who ing the ability of making he choice of suitable solveleteness of the description inication skills. The high the written examinating skills of the student; e student masters all the | nd place them in the course. we at the correct rstanding of the nich lead to the judgments, this ing methods. n allows and ion is worked out in particular, it |
| Assessment language | English | | | |
| Assessment Typology | Collegial | | | |
| Evaluation criteria and criteria for awarding marks | The evaluation is expressed through a unique mark. For the exam to be passed, the mark has to be greater or equal to 18/30. Relevant for assessment are: the identification of a suitable solution method, the knowledge of formulae and/or tools to apply and/or use, the logic and clarity of the arguing, the ability to correctly complete exercises, the number of exercises solved. | | | |
| Required readings | 2012; e-ISBN 9 downloaded from | 978-0-8: In the Lib Ins: Dav | id Gebhardi, <u>David.Gebl</u> | nal copy can be |



| Supplementary readings | Günter M. Gramlich, "Lineare Algebra: Eine Einführung", Carl Hanser Verlag. M. Abate, "Geometria", McGraw-Hill. M. Abate, "Algebra lineare", McGraw-Hill. |
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| Software used | |

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