Fakultät für Ingenieurwesen
Facoltà di Ingegneria
Faculty of Engineering

COURSE DESCRIPTION – ACADEMIC YEAR 2024/25

Course title	**Geometry**
Course code	42124
Scientific sector	MAT/05
Degree	Industrial and Mechanical Engineering L-9
Semester	1°
Year	1°
Academic year	2024-2025
Credits	8
Modular	NO

Total lecturing hours	52
Total lab hours	
Total exercise hours	21
Attendance	recommended
Prerequisites	Precalculus
Course page	In OLE

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.

Lecturers	Giovanni Modanese, Room B5.09, e-mail: Giovanni.Modanese@unibz.it, tel. +39 0471 017134 https://www.unibz.it/it/faculties/engineering/academic-staff/person/494-giovanni-modanese Laura Levaggi, Room B5.10, e-mail: laura.levaggi@unibz.it, tel. 0471 017131 https://www.unibz.it/it/faculties/engineering/academic-staff/person/27466-laura-levaggi
Scientific sector of the lecturer	MATH-04/A G. Modanese (ex MAT/07) MATH-03/A L. Levaggi (ex MAT/05)
Teaching language	English
Office hours	By appointment

Teaching assistant *(if any)*	No
Office hours	
List of topics	• Vectors and geometry of space • Matrices and their operations • Determinants and rank • Linear systems • Complex numbers and equations • Spaces R^n • Abstract vector spaces • Eigenvectors and eigenvalues • Linear transformations Detail of contents: **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. **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 $\mathbf{R}^2$: 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. Non-intersecting 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. N-roots of complex numbers, computed through the trigonometric form. Equations in a complex variable.
Teaching format	Frontal lectures and exercises.

Learning outcomes

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.

Assessment

Written exam, consisting in 8-10 exercises containing various specific questions.

Summative assessment

Form	%	Length /duration	ILOs assessed
Written exam	100	3 hours	1-5

	<table><tr><td></td><td></td><td></td><td></td></tr></table> With reference to Learning Outcomes 1-5, the assessment is based on the following points: 1) The student must understand the questions and place them exactly in the context of the theory explained in the course. 2) The student must solve the exercises and arrive at the correct result, thus applying the knowledge and understanding of the course issues. 3) The student must describe the calculations which lead to the final result, thus proving the ability of making judgments, this being evidenced by the choice of suitable solving methods. 4) The clarity and completeness of the description allows and evaluation of communication skills. 5) Altogether, the way in which the written examination is worked out allows to assess the learning skills of the student; in particular, it allows to see whether the student masters all the program, or some sections are missing.
Assessment language	English
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	Geza Schay, A concise introduction to linear algebra, Birkhauser, 2012; e-ISBN 978-0-8176-8325-2 (free personal copy can be downloaded from the Library).
Supplementary readings	Günter M. Gramlich, „Lineare Algebra: Eine Einführung", Carl Hanser Verlag. M. Abate, "Geometria", McGraw-Hill. M. Abate, "Algebra lineare", McGraw-Hill.