UNIVERSITÀ DEGLI STUDI DI BARI ALDO MORO

CONSIGLIO INTERCLASSE IN MATEMATICA

COURSE OF STUDY THREE-YEAR BACHELOR PROGRAMME IN MATHEMATICS

ACADEMIC YEAR 2023-2024

ACADEMIC SUBJECT GEOMETRY 1

General information	
Programme year	First
Term	First semester (October 2, 2023 – January 15, 2024)
European Credit Transfer and Accumulation System credits (ECTS)	8
SSD	MAT/03 – Geometry
Language	Italian
Mode of attendance	Not mandatory

Lecturers		
Name and surname	Maria Falcitelli (instructor of record)	Amedeo Altavilla
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Telephone	+39 080 544 2844	+39 080 544 2663
Department and office	Department of Mathematics room 9 third floor	Department of Mathematics room 14 second floor
Virtual meeting room		
Web page	https://www.dm.uniba.it/it/members/falcitelli	https://www.dm.uniba.it/it/members/altavilla
Office hours	Days and times have to be arranged by e-mail.	Days and times have to be arranged by e-mail.

Work schedule	Total	Lectures	Hands-on learning (recitations/tutoring)	Self-study
Hours	200	40	30+25	105
ECTS credits	8	5	2+1	

Learning objectives	
	Acquiring basic concepts of linear algebra which will be used in several courses

Course prerequisites	
	Basic concepts in Mathematics taught in high school

Syllabus	
Course contents	Algebraic structures Binary operations and algebraic structures. Groups, subgroups and elementary properties. Rings, integral domains, fields, subfields. Homomorphisms of groups and fields. The kernel and image of a homomorphism. Complex numbers and the field of complex numbers. The ring of polynomials over the field of complex numbers. Matrices and linear systems. Matrices with elements over field. Transpose of matrix. Diagonal, symmetric and skew-symmetric matrices. Sum and product of matrices.

	The group GL (n, k) and its subgroups. Rank of a matrix and properties. Determinant of a square matrix and its properties. Theorem of Binet. Laplace's rule. Cramer's rule. Theorem of Rouchè- Capelli. Systems of linear equations. Homogeneous systems. Vector spaces. Vector spaces over a field K: properties and fundamental examples. Polynomials in one indeterminate. Operations on polynomials and the vector space of polynomials. The vector space of matrices. Vector subspaces, examples. Intersection, sum, direct sum of vector subspaces. Supplementary subspaces. Vector space generated by n vectors. Finitely generated vector spaces . Linearly independent and dependent vectors. Bases of a vector space. Components of a vector with respect to a basis. Dimension of a vector space. Grassmann identity. Existence of a supplementary subspace of a vector subspace. Changes of bases. Orientations. Linear maps Linear maps: characterization and properties. Fundamental examples. The kernel and image of a linear map. Existence and uniqueness of linear maps. Characterization of monomorphisms and isomorphisms. Linear forms and dual space. Matrices associated to a linear map. Linear map associated to a matrix. Endomorphisms. Definition of endomorphism. Eigenvectors, eigenvalues and eigenspaces of an endomorphism. The characteristic polynomial . Algebraic and geometric multiplicity of an eigenvalue. Diagonalizable endomorphisms and matrices. Diagonalization criteria. Bilinear forms Definition of bilinear form. Symmetric and skew-symmetric bilinear forms. Matrices associated to a bilinear form. Congruent matrices. Orthogonal vectors. Orthogonal complement of a vector subspace. Fourier coefficient. Orthogonal bases. Diagonalization of a symmetric bilinear form. Symmetric bilinear forms on a complex vector space. Quadratic forms. Sylvester' s Theorem. Signature of real quadratic form: semidefinite, definite and indefinite forms.
Reference books	E. Sernesi, Geometria 1, Boringhieri A. Facchini, Algebra e Matematica discreta, Zanichelli E. Abbena, A.M. Fino, G.M. Gianella, Algebra lineare e Geometria analitica, Vol. I, II, Aracne. E. Schlesinger, Algebra lineare e Geometria, Zanichelli L. Mauri, E. Schlesinger, Esercizi di algebra lineare e geometria, Zanichelli.
Additional course materials	
Repository	

Expected learning outcomes	
Knowledge and understanding	Acquiring basic concepts, such as matrices, linear systems, vector spaces, linear maps, eigenvalues, bilinear forms
Applying knowledge and understanding	The acquired knowledge is useful in many branches of Mathematics, such as affine and projective Geometry, Analysis and Calculus
Soft skills	*Making judgements*: Ability to understand the consistency of a proof. Ability in problem solving
	Communication skills: Acquiring mathematical basic language.

	Learning skills: Acquiring suitable learning methods.

Teaching methods	
	Lectures and exercises

Assessment	
Assessment methods	
Evaluation criteria	• *Knowledge and understanding: Acquiring basic concepts and standard mathematical proof techniques.* • *Applying knowledge and understanding: Students should be able to solve problems related with the subject of the course* • *Making judgment: Ability to analyse the consistency of the logical arguments used in proofs and problems* • *Communication skills: Students should be able to explain a concept and the methods uised in solving problems, ability in explaining the acquired knowledge* *Learning skills: Ability in understanding texbooks dealing with the subject of the course.*
Grading policy	Exam consisting in a written part (exercises) and in an oral exposition (definitions, statements and proofs)

Further information	