Syllabus

Course Description

Course Title	Introduction to Linear Algebra and Discrete Mathematics
Course Code	76435
Course Title Additional	
Scientific-Disciplinary Sector	MATH-02/A
Language	English
Degree Course	Bachelor in Informatics and Management of Digital Business
Other Degree Courses (Loaned)	
Lecturers	Prof. Bruno Carpentieri, Bruno.Carpentieri@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/38064
Teaching Assistant	
Semester	First semester
Course Year/s	1
CP	6
Teaching Hours	40
Lab Hours	20
Individual Study Hours	90
Planned Office Hours	18
Contents Summary	• Background on complex numbers, trigonometry and polynomials, sets, functions and counting • Vectors and matrices • Linear systems • Graphs and matrix representations • Logic of compound statements • Mathematical induction and recursion
Course Topics	This course provides a comprehensive introduction to fundamental concepts of linear algebra and discrete mathematics, with a strong emphasis on applications to computer science and digital business.

	It develops both theoretical foundations and problem-solving skills, combining lectures with practical exercises. Linear Algebra Vectors: addition, scalar multiplication, linear combinations, representations, dot product, orthogonality, vector lengths and angles, unit vectors, and vector inequalities (Cauchy–Schwarz, triangle inequalities). Matrices: notation, basic operations (addition, scalar multiplication, transpose, conjugate transpose), matrix multiplication, identity and inverse matrices, powers of matrices, properties of matrix operations. Linear Systems: formulation, solution methods, inverse matrices, independence and dependence, singular systems, practical examples (Google PageRank, electrical circuits). Gaussian Elimination: elimination process, back substitution, equivalent systems, operation counts, common breakdowns (no solution, infinite solutions, zero pivots). LU Factorization and Gauss–Jordan Method: triangular factorization, systematic solution of systems. Rectangular Systems and Rank: echelon forms, reduced row echelon form, rank factorization, column relations, and consistency criteria. Geometric Interpretations: planes, algebra of planes, consistency and meaning of rank. Discrete Mathematics Graphs: basic definitions and terminology, graph representations (adjacency matrix, directed/undirected graphs), applications to networks, the World Wide Web, and knowledge representation. Graph Properties: simple graphs, complete and bipartite graphs,

	subgraphs, degrees, and vertex properties. Walks on Graphs: Euler trails and circuits, connected components, adjacency matrices, counting walks of fixed length. Graph Centrality: degree, closeness, and betweenness centrality, and their interpretation in network analysis. Logic of Compound Statements: propositions, logical operators, truth tables, negations, conjunction, disjunction, exclusive or, inequalities, and order of operations. Logical Equivalence: De Morgan's laws, tautologies, contradictions, simplifying statement forms, and equivalence transformations. Validity of Arguments: conditional statements, contrapositives, converse/inverse, necessary and sufficient conditions, Modus Ponens, Modus Tollens, proof by cases, contradiction rule. Mathematical Induction and Recursion: principle of induction, examples of recursive definitions and proofs. Additional Background Topics Review of complex numbers, trigonometry, and polynomials as needed. Sets, functions, and basic counting principles. The course integrates theory with practical applications, encouraging students to connect abstract mathematical concepts with real-world computational problems. Students will gain experience in formal reasoning, problem-solving, and the use of mathematics as a tool for computer science and data-driven decision-making.
Keywords	Linear algebra, vectors, matrices, linear systems, Gaussian elimination, LU factorization, rank, consistency, discrete mathematics, sets, functions, counting, graphs, adjacency matrix, Euler circuits, graph centrality, logic, truth tables, logical equivalence, arguments, mathematical induction, recursion,

	computer science applications, PageRank, networks, problem solving.
Recommended Prerequisites	None.
Propaedeutic Courses	
Teaching Format	This course will be delivered through a combination of formal lectures and exercises.
Mandatory Attendance	Attendance is not compulsory, however, it is recommended. Non-attending students have to contact the lecturer at the start of the course to agree on the modalities of the independent study.
Specific Educational Objectives and Learning Outcomes	Type of course: "di base" for L-31 Scientific area: "Formazione matematica-fisica" for L-31 The aim of this course is to present a rather comprehensive treatment of linear algebra and discrete mathematics, giving a general overview of the field, giving a general overview of the field. It covers vector, matrix and numbers theory, sets, functions and graphs to some degree of mathematical logic and rigour, emphasizing topics that are in support of computer science. The course also provides practice in using the tools of mathematics to solve problems and to make judgements autonomously. Knowledge and understanding: • D1.1 - Possess basic knowledge of mathematical analysis, algebra, numerical calculation and optimisation methods which support computer science and advanced economics. Applying knowledge and understanding: • D2.1 - Ability to use mathematics and statistical data analysis tools to solve computational problems. Learning skills • D5.1 - Learning ability to undertake further studies with a high degree of autonomy.
Specific Educational Objectives and Learning Outcomes (additional info.)	
Assessment	Written exam, consisting of a set of verification questions, transfer of knowledge questions and exercises. The aim of the assessment is to check to which degree students have mastered the following learning outcomes:

	1) knowledge and understanding, 2) applying knowledge and understanding, 3) making judgment. The same rules apply to both attending and non-attending students.
Evaluation Criteria	Final Written Exam, 100% covering the full program. Written exam questions will be evaluated in terms of correctness, clarity, quality of argumentation, problem solving ability. The same rules apply to both attending and non-attending students.
Required Readings	· Introduction to Linear Algebra, Fifth Edition, author: Gilbert Strang, Publisher: Wellesley-Cambridge Press, Print ISBN: 978-0980232776 · Algebra lineare (Italian), First Edition, author: Gilbert Strang, Publisher: Apogeo Education, Print ISBN: 978-8838786075 · Matrix Analysis and Applied Linear Algebra, author: Carl D. Mayer, Publisher: SIAM, Print ISBN: 978-0898714548 · Discrete Mathematics with Applications, Fourth Edition, author: Susanna S. Epp, Publisher: Cengage Learning, Print ISBN: 978-0495391326 Subject Librarian: David Gebhardi, David.Gebhardi@unibz.it
Supplementary Readings	· Coding the Matrix Linear Algebra through Applications to Computer Science, First Edition, author: Philip N. Klein, Publisher: Newtonian Press, Print ISBN: 978-0615880990 · Discrete Mathematics and its Applications, Seventh Edition, author: Kenneth H. Rosen, Publisher: McGraw-Hill, Print ISBN: 978-0073383095
Further Information	
Sustainable Development Goals (SDGs)	Quality education