Syllabus

Course Description

Course Title	Computational Security
Course Code	76253
Course Title Additional	
Scientific-Disciplinary Sector	MAT/08
Language	English; Italian
Degree Course	Bachelor in Computer Science
Other Degree Courses (Loaned)	
Lecturers	Prof. Bruno Carpentieri, Bruno.Carpentieri@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/38064 Prof. Fabrizio Maria Maggi, maggi@inf.unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/41895
Teaching Assistant	
Semester	All semesters
Course Year/s	3
CP	12
Teaching Hours	120
Lab Hours	40
Individual Study Hours	210
Planned Office Hours	
Contents Summary	• Introduction to Computational Modelling and Finite Precision Computation • Matrix Factorization Methods: LU, Cholesky, and QR Factorization • Data-Driven Approaches in Data Science: Principal Component Analysis (PCA), Data Compression (SVD), and Linear and Nonlinear Regression

	• Iterative Methods for Solving Nonlinear Equations and Optimization • Numerical Methods for Solving Ordinary Differential Equations (ODEs) • The Google PageRank Problem and Numerical Methods for Eigenvalue Computation • Basic definitions: CIA, threat, attack, vulnerability, access control • Risk assessment • Basics of cryptography • Network attack and defense • Usability • Security policies
Course Topics	Computational Mathematics aims to equip students with the knowledge and skills to derive, analyze, and implement numerical methods for solving systems of linear equations, computing eigenvalues and singular values of matrices, and approximating functions and roots. Students will engage with both exact and finite precision arithmetic to solve mathematical problems and study the underlying theory that supports numerical solutions. Key topics include stability, error analysis, and efficiency in numerical linear algebra and approximation algorithms. The course also introduces Matlab as a software environment for numerical computing, enabling high-performance matrix manipulation, data visualization, and efficient algorithm implementation. Information Security introduces the field of information security, covering both technical and management aspects. Students will learn the foundational principles of security and explore practical strategies for protecting information systems. The course offers a comprehensive view of how to identify vulnerabilities and implement effective safeguards in modern computing environments.
Keywords	Computational modeling, finite precision arithmetic, floating-point errors, conditioning, Gaussian elimination, LU factorization, Cholesky factorization, nonlinear equations, Newton's method, ODEs, Euler's method, convergence analysis, SVD, PCA, regression, Gram–Schmidt, QR factorization, graph theory, centrality,

	PageRank, power method, eigenvalues, scientific computing, data-driven models.
Recommended Prerequisites	Students should have done Linear Algebra, and the following courses are suggested to be done: Software Engineering, Introduction to Programming, Object Oriented and Functional Programming. Students should have a solid mathematical foundation and be familiar with basic programming concepts, data structures and algorithms. These prerequisites are covered in any Bachelor degree in Computer Science.
Propaedeutic Courses	
Teaching Format	The course includes frontal lectures and lab sessions.
Mandatory Attendance	Attendance is not compulsory; non-attending students may contact the lecturer at the start of the course to get support on the modalities of the independent study
Specific Educational Objectives and Learning Outcomes	Knowledge and Understanding – D1.1 Have a solid knowledge of mathematical, algebra, numerical calculus, and elementary logic that are in support of computer science. – D1.14 Know critical security aspects of information systems, the basic concepts of security and techniques for the development of secure systems. Applying knowledge and understanding – D2.1 Be able to use the tools of mathematics and logic to solve problems. – D2.11 Be able to evaluate the quality of information systems and to identify critical aspects. – D2.17 Ability to analyze and improve data privacy and data security features in the context of complex software infrastructures. – D2.19 Be able to apply your own knowledge in different working contexts. Ability to make judgments – D3.2 Be able to work autonomously according to the own level of knowledge and understanding. Communication skills – D4.1 Be able to use one of the three languages English, Italian and German, and be able to use technical terms and communication appropriately. – D4.5 Be able to work in teams for the realization of IT

	systems. Learning skills – D5.1 Have developed learning capabilities to pursue further studies with a high degree of autonomy. – D5.3 Be able to follow the fast technological evolution and to learn cutting edge IT technologies and innovative aspects of last generation information systems.
Specific Educational Objectives and Learning Outcomes (additional info.)	
Assessment	Final exam: The exam covers topics from both Computational Mathematics and Information Security, each contributing 50% to the final grade. The Computational Mathematics part consists of a written exam with verification questions, knowledge transfer tasks, and exercises. The Information Security part includes a project, aimed at assessing knowledge application, and an oral exam with verification questions and discussion of the project. A midterm test will be offered at the end of the Computational Mathematics module, covering only its content. Students who score at least 18 out of 30 on the midterm will only need to complete the Information Security part in the final exam.
Evaluation Criteria	The exam is evaluated based on the correctness and clarity of answers, the ability to summarize and critically evaluate concepts, the capacity to connect different topics, problem-solving skills, critical thinking, and the quality of argumentation. To pass the exam, students must achieve a minimum score of 18 out of 30 in each module. Each module contributes 50% to the final grade. For Computational Mathematics, the assessment is based entirely on the written exam. For Information Security, the evaluation is split between a project (30%) and an oral exam (70%). The project assesses the ability to apply knowledge in a practical setting, to summarize concepts, to explain things balancing conciseness and completeness. The oral exam assesses the clarity of answers, the ability to recall principles and methods used of information security and the applied knowledge acquired with the project development.
Required Readings	Anne Greenbaum and Tim P. Chartier. Numerical Methods: Design, Analysis, and Computer Implementation of Algorithms. Princeton University Press, Princeton, N.J, illustrated edition, April

	2012. ISBN 978-0-691-15122-9. George Lindfield and John Penny. Numerical Methods: Using MATLAB. Academic Press, Waltham, MA, 3rd edition, July 2012. ISBN 978-0-12-386942-5. Dorothy C. Attaway Ph.D. MATLAB: A Practical Introduction to Programming and Problem Solving. Butterworth-Heinemann, Amsterdam Boston, 3rd edition, July 2013. ISBN 978-0-12-405876-7. Slide materials and scientific articles
Supplementary Readings	Kendall Atkinson. An Introduction to Numerical Analysis. Wiley, New York, 2nd edition, January 1991. ISBN 978-0-471-62489-9. Cleve B. Moler. Numerical Computing with MATLAB. Society for Industrial and Applied Mathematics, Philadelphia, Pa, January 2004. ISBN 978-0-89871-560-6. Computer & Internet Security: A Hands-on Approach 3rd Edition (ISBN: 978-17330039-4-0) Computer Security: A Hands-on Approach, 3rd Edition (ISBN: 978-17330039-5-7) Internet Security: A Hands-on Approach 3rd Edition (ISBN: 978-17330039-6-4)
Further Information	Software used: – MATLAB (https://www.mathworks.com/products/matlab.html) – Tools provided during lab sessions
Sustainable Development Goals (SDGs)	Quality education

Course Module

Course Constituent Title	Computational Mathematics
Course Code	76253A
Scientific-Disciplinary Sector	MAT/08
Language	Italian
Lecturers	Prof. Bruno Carpentieri, Bruno.Carpentieri@unibz.it https://www.unibz.it/en/faculties/engineering/academic-

	staff/person/38064
Teaching Assistant	
Semester	First semester
CP	6
Responsible Lecturer	
Teaching Hours	40
Lab Hours	20
Individual Study Hours	90
Planned Office Hours	
Contents Summary	• Introduction to Computational Modelling and Finite Precision Computation • Matrix Factorization Methods: LU, Cholesky, and QR Factorization • Data-Driven Approaches in Data Science: Principal Component Analysis (PCA), Data Compression (SVD), and Linear and Nonlinear Regression • Iterative Methods for Solving Nonlinear Equations and Optimization • Numerical Methods for Solving Ordinary Differential Equations (ODEs) • The Google PageRank Problem and Numerical Methods for Eigenvalue Computation
Course Topics	Computational Mathematics aims to equip students with the knowledge and skills to derive, analyze, and implement numerical methods for solving systems of linear equations, computing eigenvalues and singular values of matrices, and approximating functions and roots. Students will engage with both exact and finite precision arithmetic to solve mathematical problems and study the underlying theory that supports numerical solutions. Key topics include stability, error analysis, and efficiency in numerical linear algebra and approximation algorithms. The course also introduces Matlab as a software environment for numerical computing, enabling high-performance matrix manipulation, data visualization, and efficient algorithm implementation.
Teaching Format	The course includes frontal lectures and lab sessions.
Required Readings	– Anne Greenbaum and Tim P. Chartier. Numerical Methods:

	Design, Analysis, and Computer Implementation of Algorithms. Princeton University Press, Princeton, N.J, illustrated edition, April 2012. ISBN 978-0-691-15122-9. – George Lindfield and John Penny. Numerical Methods: Using MATLAB. Academic Press, Waltham, MA, 3rd edition, July 2012. ISBN 978-0-12-386942-5.
Supplementary Readings	– Kendall Atkinson. An Introduction to Numerical Analysis. Wiley, New York, 2nd edition, January 1991. ISBN 978-0-471-62489-9. – Cleve B. Moler. Numerical Computing with MATLAB. Society for Industrial and Applied Mathematics, Philadelphia, Pa, January 2004. ISBN 978-0-89871-560

Course Module

Course Constituent Title	Information Security
Course Code	76253B
Scientific-Disciplinary Sector	MAT/08
Language	Italian
Lecturers	Prof. Fabrizio Maria Maggi, maggi@inf.unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/41895
Teaching Assistant	
Semester	Second semester
CP	6
Responsible Lecturer	
Teaching Hours	40
Lab Hours	20
Individual Study Hours	90
Planned Office Hours	
Contents Summary	• Basic definitions: CIA, threat, attack, vulnerability, access control • Risk assessment • Basics of cryptography • Network attack and defense

	• Usability • Security policies
Course Topics	Information Security introduces the field of information security, covering both technical and management aspects. Students will learn the foundational principles of security and explore practical strategies for protecting information systems. The course offers a comprehensive view of how to identify vulnerabilities and implement effective safeguards in modern computing environments.
Teaching Format	The course includes frontal lectures and lab sessions.
Required Readings	Dorothy C. Attaway Ph.D. MATLAB: A Practical Introduction to Programming and Problem Solving. Butterworth-Heinemann, Amsterdam Boston, 3rd edition, July 2013. ISBN 978-0-12-405876-7. Slide materials and scientific articles
Supplementary Readings	Computer & Internet Security: A Hands-on Approach 3rd Edition (ISBN: 978-17330039-4-0) Computer Security: A Hands-on Approach, 3rd Edition (ISBN: 978-17330039-5-7) Internet Security: A Hands-on Approach 3rd Edition (ISBN: 978-17330039-6-4)