UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Fisica e Chimica - Emilio Segrè
ACADEMIC YEAR	2022/2023
BACHELOR'S DEGREE (BSC)	PHYSICS
SUBJECT	NUMERICAL METHODS FOR PHYSICS
TYPE OF EDUCATIONAL ACTIVITY	C
AMBIT	10699-Attività formative affini o integrative
CODE	19973
SCIENTIFIC SECTOR(S)	MAT/07
HEAD PROFESSOR(S)	PAGANO PAOLO Professore Associato Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	6
INDIVIDUAL STUDY (Hrs)	94
COURSE ACTIVITY (Hrs)	56
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	2
TERM (SEMESTER)	1° semester
ATTENDANCE	Mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**PAGANO PAOLO** Tuesday 11:30 13:30 Dipartimento di Fisica e Chimica, in via Archirafi, 36.Stanza 109.

DOCENTE: Prof. PAOLO PAGANO

PREREQUISITES	The prerequisites for profitable learning of numerical methods and achieve the objectives which it is intended are a basic knowledge of differential and matrix calculus, and of computer science and programming.
LEARNING OUTCOMES	Knowledge and understanding: Competence and basic management of numerical analysis topics. Applying knowledge and understanding: Design, implementation and testing of numerical algorithms in C programming or other. Evaluation of the areas of validity of methods and numerical errors. Making judgments: Acquisition of objective assessment tools through validation test programs. Assessment and selection of different numerical solutions according to the problem to be addressed. Communication skills: Acquisition of presentation skills through full answers to specific questions asked during the laboratory exercises. Learning skills: Ability to apply computer science concepts in the practical implementation of algorithms.
ASSESSMENT METHODS	The grading takes into account the outcome of laboratory exercises and an individual test. The individual test consists of a test to be filled which is then discussed orally with the student. The test includes multiple choice, open and filling questions, and covers all of the topics covered in the course. The exercises test the application and managing of the methods and their results, especially with regard to uncertainties. The written test tests the knowledge of the subjects in their theoretical and more critical aspects. The oral discussion allows the student to improve the weaknesses in the written test, with verification of the correct use of language and the ability of expression. The grading will be given according to: 30-30 cum laude: Excellent knowledge of the topics, excellent use of language, good analytical ability, the student is able to apply the knowledge to solve problems proposed 26-29: Good mastery of the subjects, full use of the language, the student is able to apply knowledge to solve problems proposed 24-25: Basic knowledge of the main topics, discrete properties of language, with limited ability to independently apply the knowledge to the solution of the proposed problems 21-23: He/she does not have full mastery of the main issues but he/she has knowledge, satisfactory use of the language, poor ability to independently apply the knowledge acquired 18-20: Minimum basic knowledge of the main topics and the technical language, very little or no ability to independently apply the knowledge acquired Insufficient: He/she does not have an acceptable knowledge of the contents of the topics covered in the course
EDUCATIONAL OBJECTIVES	The purpose of the course is to provide students with the skills and knowledge that make them able to autonomously tackle the main problems of numerical analysis applied to physics.
TEACHING METHODS	The course of numerical methods takes place in the first semester of the second year of the degree in Physical Sciences. The teaching activity develops through lessons and examples of application and programming of numerical methods. Five to six practice exercises are planned in the computer laboratory or remotely, covering different topics of the course: the students, in groups of one or two, answer a numerical test by writing and running a program and providing the answers to the questions in a text file in which they discuss the results. The exercises are subject to individual grading, which is part of the final grading.
SUGGESTED BIBLIOGRAPHY	Testi base: [Da Introduzione a Sistemi di equazioni lineari (from Introduction to Systems of linear equations)] - J. Murphy, D. Ridout, B. McShane, Numerical Analysis, Algorithms, and Computation, Ellis Horwood, 1988. [Simulazioni MonteCarlo (MonteCarlo Simulations)] - P.R. Bevington, D.K. Robinson, Data Reduction and Error Analysis for the Physical Sciences, McGraw-Hill, 1992. Testi di approfondimento: [Parallel computing] - B. Barney, Introduction to Parallel Computing, https://computing.llnl.gov/tutorials/parallelcomp/, 2015

SYLLABUS

Hrs	Frontal teaching
3	Introduction: numerical representation and truncation errors. Examples of programming on Unix operating systems
5	Non-linear algebraic equations: simple iterative methods, sequence generating functions, test for convergence. Rate of convergence. Bisection method. Newton-Raphson method. Examples and programming.
5	Interpolation: notation and difference operators. Finite difference formulae. Examples and programming.

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Hrs	Frontal teaching
4	Numerical integration: Newton-Cotes and composite formulae. Trapezium rule. Simpson rule. Open integration. Examples and programming.
8	Differential equations: introduction, initial value problems, multi-step predictor-corrector methods. Starting methods. Accuracy of multi-step methods: truncation error, convergence, stability. Runge-Kutta single-step methods. Examples and programming.
5	Systems of linear equations: substitution method. Gauss elimination method. Pivoting. LU factorization method. Iterative methods. Examples and programming.
6	Monte Carlo methods: simulation concept, random and pseudo-random numbers. Transformation method. Look-up table method. Rejection method. Gaussian distributions methods, Box-Mueller method. Methods for Poisson and exponential distributions. Examples and programming.
4	Parallel computing: concept, approaches: decomposition, shared or distributed memory. Speedup, efficiency, communication times. Notes on parallel programming with message passing (MPI)

Hrs	Workshops
2	Non-linear equations: laboratory exercise
3	Interpolation: laboratory exercise
2	Numerical integration: laboratory exercise
3	Differential equations: laboratory exercise
3	Systems of linear equations: laboratory exercise
3	Monte Carlo methods: laboratory exercise