UNIVERSITÀ DEGLI STUDI DI BARI ALDO MORO

CONSIGLIO INTERCLASSE IN MATEMATICA

General information	**Academic year 2022-2023**
Academic subject	**Numerical Analysis**
Degree programme	Mathematics - Laurea Magistrale (LM-40)
Programme year	Second
Term	First semester (September 26, 2022 – December 22, 2022)
European Credit Transfer and Accumulation System credits (ECTS)	7
Language	Italian
Attendance	Not compulsory, but strongly suggested

Lecturer	
Name and surname	Roberto Garrappa
E-mail	roberto.garrappa@uniba.it
Telephone	+39 080 544 2685
Department and office	Department of Mathematics, room 7, third floor
Virtual meeting room	
Web page	https://www.dm.uniba.it/members/garrappa
Office hours	Monday 15:00-17:00, by appointment via email

Syllabus	
Learning objectives	Learning advanced methods for numerically solving ordinary and partial differential equations
Course prerequisites	Knowledge of Numerical Computing and Matlab programming skills.
Course contents	1. Solution of initial value problems. Multistep methods: Adams methods and BDFs. Consistency, convergence and 0-stabilty. Roots conditions. Stability. Predictor-Corrector methods. 2. Numerical solution of partial differential equations. Poisson and Laplace equation. Finite difference methods: 5- and 9-points stencils. Ordering of variables. Dirichlet and Neumann conditions. Consistency, convergence and boundedness of invers of the matrix discretization and its ill-conditioning. Evolutionary problems: explicit scheme and stability. The method of Lines: consistency, stability and convergence. Crank-Nicolson method. Advection equations. Mid-point, leapfrong and Lax-Friederisch method. Fourier analysis. Variational formulation and finite element methods. 3 Numerical methods for solving large systems of linear equations. Splitting methods. Krylov subspace methods. Arnoldi and Lanczos algorithms. FOM, MinRes, GMRes and GC. Restart and convergence. 4. Numerical experiences in Matalb.
Reference books	• J.D. Lambert, Numerical Methods for Ordinary Differential Systems: The Initial Value Problem, John Wiley & Sons, 1991 • E. Hairer, S.P. Norsett and G. Wanner, Solving ODEs I, Springer 2008 • Endre Suli and David Mayers, An introduction to Numerical Analysis, Cambride 2003 • Randy LeVeque, Finite Difference Methods for Ordinary and Partial Differential Equations: Steady State and Time Dependent Problems. SIAM, 2007 Yousef Saad, Iterative Methods for Sparse Linear Systems, SIAM, 2013
Additional course materials	For each textbook there will be indicated the main chapters

Work schedule				
	Total	Lectures	Laboratories	Self-study
Hours	175	48	15	112
ECTS credits	7	6	1	

Teaching methods	
	Lectures and computer programming sessions

Expected learning outcomes	
Knowledge and understanding	Knowledge of basic techniques for developing numerical methods and studying their properties Ability of choosing the most suitable methods with respect to physical and mathematical features of each problem.
Applying knowledge and understanding	Ability of developing numerical methods also for problems not specifically studied during the lectures. Ability to optimize algorithms with respect to the available computational resources. Ability to test codes and interpretation of results.
Making judgements	Ability to select appropriate methods with respect to the problem to solve
Communication skills	Ability to describe in a proper way the problem and the procedure used for its solution.
Learning skills	Ability to study different problems with respect to those studied during the course.

Assessment and feedback	
Assessment methods	Oral exams with presentation and discussion of numerical experiments
Evaluation criteria	For the evaluation there will be considered the knowledge and understanding of the different numerical techniques, the ability of applying methods in a correct way, the ability of studying and evaluating the main properties of each method. There will be taken into consideration the ability of presenting methods and results of numerical experiments in a professional way.
Grading policy	The maximum mark for this exam is 30 and it is attributed on the basis of the above criteria.

Additional information	