UNIVERSITÀ DEGLI STUDI DI BARI ALDO MORO

CONSIGLIO INTERCLASSE IN MATEMATICA

General information	
Academic subject	**Numerical Analysis**
Degree course	Mathematics
Academic Year	2021-22
European Credit Transfer and Accumulation System (ECTS)	7
Language	Italian
Academic calendar (starting and ending date)	September 27 – December 23, 2021
Attendance	Not mandatory but strongly suggested

Professor/ Lecturer	
Name and Surname	Roberto Garrappa
E-mail	roberto.garrappa@uniba.it
Telephone	080.5442685
Department and address	*Dipartimento di Matematica – 3rd floor – Office n. 7*
Virtual headquarters	*Microsoft Teams code for tutoring: skseih0*
Tutoring (time and day)	Thursday 15:00 - 17:00 (by appointment on other days)

Syllabus	
Learning Objectives	Learning advanced methods for numerically solving ordinary and partial differential equations
Course prerequisites	Knowledge of Numerical Computing and Matlab programming skills.
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 boundary value problems. 3. 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, leapfrog and Lax-Friederisch method. Fourier analysis. Variational formulation and finite element methods. 4 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. 5. Numerical experiences in Matalb.
Books and bibliography	• 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 materials	For each textbook there will be indicated the main chapters

Work schedule			
Total	Lectures	Hands on (Laboratory, working groups, seminars, field trips)	Out-of-class study hours/ Self-study hours
Hours			
175	52	8	115
ECTS			
7	6,5	0,5	

Teaching strategy	
	Lectures and computer programming sessions
Expected learning outcomes	
Knowledge and understanding on:	• Knowledge of basic techniques for developing numerical methods and studying their properties • Ability of choosing most suitable methods with respect to physical and mathematical features of each problem.
Applying knowledge and understanding on:	• Ability of developing numerical methods also for problems not specifically studied during the lectures. • Capacità di ottimizzare gli algoritmi in base alle risorse di calcolo disponibili ○ Capacità di effettuare test adeguati dei codici sviluppati e di interpretare correttamente i risultati ottenuti.
Soft skills	• *Making informed judgments and choices:* ability of selecting the right method on the basis of the features of the problems • *Communicating knowledge and understanding:* ability of describing in a rigorous way the problem which is aimed to be solved and the approaches used for its solution. • *Capacities to continue learning:* ability of studying different problems.

Assessment and feedback	
Methods of assessment	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.
Criteria for assessment and attribution of the final mark	The maximum mark for this exam is 30 and it is attributed on the basis of the above criteria.
Additional information	