Università degli Studi di L'Aquila - Dipartimento di Ingegneria e Scienze dell'Informazione e Matematica

Course catalogue

Page compiled on 12/12/2019

Programme of Course "Numerical Methods For Linear Algebra And Optimisation"

- Code: DT0312
- Type of course unit: Elective (Master Degree in Mathematical Engineering curriculum Comune)
- Level of course unit: Postgraduate Degrees
- Semester: 2

Number of ects credits: (Master Degree in Mathematical Engineering) 6 (workload 150 hours)

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1	**Course objectives**	This is a course on numerical linear algebra and numerical optimization. Together with the theoretical inspection on the numerical methods and their features, the course is also intended to provide the basic tools to develop a reliable software implementing the studied methods and analyze the obtained results on a selection of significant test problems.
2	**Course content and learning outcomes (dublin descriptors)**	Topics of the module include: • Relevant matrix factorizations: back to LU decomposition, Cholesky decomposition. Singular value decomposition and applications (image processing, recommender systems). QR decomposition and least squares. Householder triangularization. Conditioning and stability in the case of linear systems. • Eigenvalue problems. Reduction to Hessemberg form. Rayleigh quotient, inverse iteration. QR algorithm with and without shift. Jacobi method. Givens-Householder algorithm. • Iterative methods for linear systems. Overview of iterative methods. Arnold iterations, Krylov iterations. GMRES. Lanczos method. Conjugate gradient. • Introduction to numerical optimization. Continuous versus discrete optimization. Constrained and unconstrained optimization. Global and local optimization. Overview of optimization algorithms. Convexity. • Line search methods. Convergence of line search methods. Rate of convergence. Steepest descent, quasi-Newton methods. Step-length selection algorithms. • Trust region methods. Cauchy point and related algorithms. Dogleg method. Global convergence. Algorithms based on nearly exact solutions. • Conjugate gradient methods. Basic properties. Rate of convergence. Preconditioning. Nonlinear conjugate gradient methods: Fletcher-Reeves method, Polak-Ribiere method. On successful completion of this module, the student should : • acquire the knowledge of most meaningful numerical methods for the linear algebra and optimization, as well as of their implementation in an accurate and efficient mathematical software.
3	**Course prerequisites**	Basic Numerical Analysis and matrix theory.
4	**Teaching methodsand language**	**Language**: English **Reference textbooks** • J. Stoer, R. Bulirsch, ***Introduction to numerical analysis***. Springer. 2002. • J. Nocedal, S. J. Wright, ***Numerical optimization***. Springer. 1999.
5	**Assessment methods**	Oral examination and a final project consisting in applying the developed software on a selection of test problems. The final project will be discussed in the same day of the oral examination.