Complements in Numerical Analysis A.A. 2015-2016 (6 cfu)

Language of the lessons
Italian

Topics
- Approximation of the eigenvalues and the eigenvectors of a matrix
- Linear programming and the simplex method
- Systems of nonlinear equations
- Numerical methods for ordinary differential equations with initial value conditions

Textbooks
• G. Monegato, Fondamenti di Calcolo Numerico, Edizioni C.L.U.T. Torino
• D. Bini, M. Capovani, O. Menchi, Metodi Numerici per l'algebra lineare, Zanichelli.

Learning outcomes
The knowledge and how to use of the numerical methods for approximating the solutions of the Cauchy problems and for the approximation of the the eigenvalues and the eigenvectors of a matrix. The Knowledge and how to use the methods for systms of nonlinear equations.

At the end of the course, the student will be able to establish the solvability and the well conditioning of a given problem, to find the method that numerically solve it with the smallest computational cost and the greatest number of exact significant digits, to give "apriori" estimates of the theoretical errors.

Requirements
In order to attend the course the knowledge of the arguments from the courses of Calculus I, Calculus II, Discrete Mathematics I and Numerical Analysis is required. Moreover the knowledge of Matlab is required.

Teaching methods
Theoretical lessons and tutorials in the numerical laboratory

Evaluation methods
Practical test and oral examination

Detailed content
1. Approximation of the eigenvalues and the eigenvectors of a matrix:

Eigenvalues and eigenvectors of a matrix: localization theorems and conditioning. Conditioning of an eigenvalue of algebraic multiplicity 1. The power iteration method: normalization with respect to the infinity norm and the 2 norm. The inverse power method for the computation of the smallest eigenvalue. The inverse power method for improving the approximation of an eigenvalue and for computing one of the corresponding eigenvectors. The QR method. Computational cost of the methods.

2. Linear pogramming and the simplex method
3. Systems of nonlinear equations
   The Newton-Raphson method and its modifications.
4. Numerical methods for ordinary differential equations with initial value conditions:

The Cauchy problems (IVP): conditioning and overview of the numerical methods. One-step methods: stability and convergence. Runge-Kutta methods: the choice of the step. Linear multistep methods: local truncation error and consistence, stability and convergence. Construction of the linear multistep methods. The predictor-corrector method.