Università degli Studi della Basilicata
Dipartimento di Matematica, Informatica ed Economia

COURSE: Numerical Analysis (first module of Numerical Analysis and Advanced Calculus)			
ACADEMIC YEAR:2019-20			
TYPE OF EDUCATIONAL ACTIVITY: Basic			
TEACHER: RUSSO Maria Grazia			
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phone: 0971205147		mobile (optional): 3204235379	
Language: italian			
ECTS: 6	n. of hours: 54	Campus: Potenza Dept./School: DiMIE Program: Scienze e Tecnologie Informatiche	Semester: I

EDUCATIONAL GOALS AND EXPECTED LEARNING OUTCOMES

The teaching of Numerical Analysis ng is the first teaching module of Calculus. It is a basic teaching and aims to provide some of the standard numerical techniques and their implementation in Matlab. The main knowledge will be transmitted:

- Representation of numerical data on computer and numerical error analysis.
- Numerical methods for solving linear systems.
- Factorization of matrices.
- Numerical methods for solving nonlinear equations and the case of algebraic equations.
- Approximation of functions of one variable

The main skills will be:

- Develop critical thinking regarding the choice between antagonistic methods for solving a specific numerical problem (eg. comparing the speed of convergence, stability of algorithms, the memory footprint, the computational cost).
- Achieving a good level of familiarity in the individual programming of numerical algorithms in Matlab.
- Knowing how to interpret the numerical data from the computer and know how to evaluate consistency with the expected results.

PRE-REQUIREMENTS

Are prerequisites:

- the basic topics of mathematical analysis and in particular the concepts related to the study of function: the concepts of limit, continuity, differentiability, integration of real-axis limited intervals;
- the basic concepts of discrete mathematics: vector spaces, vectors, matrices, linear systems, eigenvalues and eigenvectors;
- a basic procedural programming and knowledge of the Matlab language.

SYLLABUS

1. **Digital data and error analysis (4 hours):**
The representation of numerical data in computers. Introduction to numerical errors. Conditioning of a problem and stability of an algorithm.
2. **Algebra of matrices and linear systems (4 hours):**
Matrices, vectors and matrix norms. Conditioning of a linear system. Classes of numerical methods for solving linear systems
3. **Direct methods (6 hours + 6 hours of tutorial):**
solving triangular systems; Gauss method of elementary and pivoting. LU factorization. Cholesky factorization.
4. **SVD decomposition (2 hours):**
applications and detail on the use for image compression
5. **Iterative methods (6 hours + 6 hours of tutorial):**
generalities on iterative methods. Jacobi and Gauss-Seidel methods. Special methods for sparse matrices and the "sparse" package in Matlab.
6. **Numerical methods for the calculation of zeros of nonlinear equations (6 hours + 4 hours of tutorial)**:
bisection method and Newton method. Analysis for the calculation of polynomial zeros.

7. **Approximation of functions (6 hours + 4 hours of tutorial):**
Approximation by linear and cubic spline functions. Algorithm of construction and convergence estimates. Simultaneous approximation of a function and of its derivatives.

TEACHING METHODS
Theoretical lessons, Laboratory tutorials

EVALUATION METHODS
The aim of the examination is to test the level of achievement of the above mentioned educational goals.
The examination consists of two tests which take place on different days.
The first test is written and is divided into two parts:
• a written and practical one with computer use (n. 3 questions for which the student has to choose the most appropriate algorithms to solve the problems, calculate solutions and comment critically the obtained results) on all matters treated in the first module;
• a written part in which it si required the solution of at least n. 2 of n. 3 traditional exercises on all topics covered in the second module.
The scheduled time for this test is 3 hours. To pass this test you must acquire at least 16 points on 30.
The second test is oral and it is accessed only after passing the written test. The final grade will be obtained with the average grade of the two tests and the examination will be considered passed if the average of the marks obtained will be at least 18/30.

During the course it is also provided four tests of intermediate verification, two for each module, each of which is passed with a minimum score of 16/30. For each of the tests the required time will be 2 hours. The first two tests will cover the topics covered in the first module, the other two instead will focus on topics of the second module. In the intermediate tests are scheduled to be open-ended exercises that questions about the theoretical knowledge. The examination will be considered passed if all four races be overcome. The final vote will be given to the average of four tests with the addition of 2 of points (bonus).
The result of the tests of intermediate verification, together with the ascertained frequency of at least 6 laboratories (for the first module) and of at least 6 exercises (for the second module), exempt the student from the oral test.

In the event that the student passes the tests of intermediate checks related to only one of the two modules during the test exam, he may ask to be excused on the topics related to the module passed through the intermediate tests. In this case, the final vote will consist of the average of the votes gained during the intermediate tests (the average of the scores of the two passed tests without added bonus) and the vote acquired during the examination of, only arguments of the failed module by means of the intermediate tests.

TEXTBOOKS AND ON-LINE EDUCATIONAL MATERIAL
Notes are available on the web site of the course: informatica.unibas.it/moodle

Textbooks:
1. G. Monegato, Fondamenti di calcolo numerico, CLUT (Torino)
2. A. Quarteroni, R. Sacco, F. Saleri, Matematica numerica, Springer
3. A. Kharab, R. Guenther, An Introduction to Numerical Methods. A MATLAB approach, CRC Press, Taylor & Francis Group, 2019
4. G. Rodriguez, S. Seatzu, Introduzione alla Matematica Applicata e Computazionale, Pitagora Editrice Bologna, 2010

INTERACTION WITH STUDENTS
During the first lesson of the course the objectives, the program, the verification methods and all information related to the operation, including the description of the web page of the course are described.
The presentation of the first class file is loaded on the course website and available to students.

Access to the course website, which is part of an e-learning platform (Moodle) is open for the student of the course and contains, in addition to all the material used during the course, also a Forum News that allows course teachers to communicate directly with students and vice versa.
The site has also a module that allows students to "sign up" and be able to book for the course tests.

Weekly office hours: Thursday from 15.30 to 17.30 at the office of teacher (3D-building room 216)
In addition to weekly reception, the teacher is available through its e-mail (mariagrazia.russo@unibas.it), phone (3204235379), and the aforementioned News Forum of the course web site. Moreover she receives by appointment on different days from Thursday.

EXAMINATION SESSIONS (FORECAST)[1]
24/02/2020, 04/05/2020, 29/06/2020, 20/07/2020, 14/09/2020, 18/12/2020

SEMINARS BY EXTERNAL EXPERTS YES □ NO x

FURTHER INFORMATION

[1] Subject to possible changes: check the web site of the Teacher or the Department/School for updates.