DISCIPLINE ACADEMIC SHEET

ACADEMIC YEAR 2015 - 2016

1. PROGRAMME DATA

1.1 Higher Education Institution	*UNIVERSITY OF CRAIOVA*
1.2 School	*Automation, Computers and Electronics*
1.3 Department	*Computers and Information Technology*
1.4 Field of Study	*Computers and Information Technology*
1.5 Study Level[1]	*L (licence/ undergraduate)*
1.6 Study Program (name/code)[2] /Calification	*Computers /* L206010101010

2. DISCIPLINE DATA

2.1 Discipline Name				**Numerical Methods**					
2.2 Course Activities Holder				Associate Professor, Ph.D, Maria-Magdalena BOUREANU					
2.3 Practical Activities Holder				Associate Professor, Ph.D, Maria-Magdalena BOUREANU					
2.4 Study Year	**1**	2.5 Semester	**2**	2.6 Discipline Type (content)[3]	**DF**	2.7 Discipline Conditions (mandatory)[4]	**DI**	2.8Evaluation Type	E

3. ESTIMATED TOTAL TIME (hours per semester of teaching activities)

3.1 Number of hours per week	**4**	in which: 3.2 couse	**2**	3.3 seminar/laboratory/project	**2**
3.4 Total hours of curriculum	**56**	in which: 3.5 course	**28**	3.6 seminar/laboratory/project	**28**

3.7 Time distribution	hours
▪ Study after manual, course support, bibliography and notes	**20**
▪ Additional documentation in library, on specialized electronic platforms and field	**14**
▪ Training seminars / labs, homework, portfolios and essays	**14**
▪ Tutoring	**-**
▪ Examinations	**2**
▪ Other activities: consultations, student meetings	**2**

Total hours per individual activities	**52**
3.8 Total hours per semester[5]	**108**
3.9 Number of credits[6]	**4**

4. PRECONDITIONS (where appropiate)

4.1 of curriculum	Linear algebra, Mathematical Analysis, Differential equations, Programming.
4.2 of competence	--

5. CONDITION (where appropiate)

5.1. of the course	The teaching is thought to be both explanatory and interactive, at the blackboard, by actively engaging the students into the learning process. Thus, 70% of the activity represents a theoretical teaching based on the course syllabus, while 30% of the activity represents interaction with students, to make sure that the learning process is not only smooth, but also interesting enough to make students getting involved. All the new notions, definitions, properties and theorems are introduced rigorously, but we choose to focus on the statement of the new theorems and on their applicability, instead of their proofs. Consequently, only part of the proofs are introduced to the students (for the rest of them we send the interested students to appropriate references) and we present applications of the theorems since we consider that a calculus made by hand represents one of the best ways to make sure that the students understand correctly the algorithms.
5.2. of seminar/ laboratory/project	The laboratory classrooms are very well equipped with all that is needed for this discipline: computers, the appropriate programming languages, network and internet connection. Our goal is to make students better understand the numerical

	algorithms and to be able to utilize them by means of programming languages.

6. SPECIFIC LEARNED SKILLS [7]

Professional competences	▪ C1. *Working with fundamentals of mathematics, engineering and informatics.* C1.1. Proper use in professional communication of the eigen concepts of calculability, complexity, programming paradigms and modeling of computer and communications systems. C1.2. Using theories and specific tools (algorithms, charts, models, protocols, etc.) to explain the operation and structure of hardware, software and communication systems. ▪ C3. *Solving problems using computer science and engineering tools.* C3.1. Identification of a class of problems and solving methods specific for computer systems. C3.2. Using interdisciplinary knowledge, solution patterns and tools to conduct experiments and interpret their results. C3.3. Applying solution by means of engineering tools and methods.
Transversal Competences	▪ CT1. *Honorable, responsible, ethical behavior, within the law, to ensure the reputation of the profession.* ▪ CT3. *Proof of the spirit of initiative and action for updating professional, economic and organizational culture knowledge.*

7. DISCIPLINE OBJECTIVES (based on the specific learned competences)

7.1 General objective of the discipline	This is a fundamental discipline which introduces to students the main numerical methods concerning linear and nonlinear algebra, function approximation, differential and integral calculus, numerical resolution of differential equations and partial differential equations. It also aims to enhance the ability to analyze different mathematical models in the engineering field, using the numerical techniques and to solve specific problems by turning the numerical methods into programming languages. The laboratory focuses on a deep and thorough understanding and the optimal algorithmization of the knowledge thought during the course, aiming the development of numerical codes and their testing on different kinds of applications. As a result, the student is given the theoretical and practical instruments to find the solution of some applicative problems and is able to analyze the results obtained.
7.2 Specific objectives	The specific objectives are: ▪ To get acquainted with the basics of Numerical Analysis: interpolations and adjustments; algebrical systems, both linear and nonlinear; eigenvectors and eigenvalues; learning the idea of approxiamation and the treatment of the error; iterative methods and estimation of the error; numerical integration; differential equations and systems; approximation of the roots of equations, and computation of the errors of the roots. ▪ To acquire the skills of recognizing the main types of problems that appear in Numerical Analysis and to be able to select and to apply the appropriate methods in order to solve them. ▪ To induce the ability to write the pseudo-codes for simple algorithms and then to transpose them into programming languages, like C++.

8. CONTENT

8.1 COURSE (content units)	No hours	Teaching methods
Ch. 1 Numerical methods in algebra 1.1 Types of matrices. 1.1.1 Square matrices of order n. 1.1.2 Diagonal matrices; unit matrix of order n. 1.1.3. Upper (lower) triangular matrix of order n. 1.1.4. Band matrix of order n. 1.2. Matricial transformations for solving linear systems. 1.2.1. LR factorization for a real matrix of order n; tridiagonal and pentadiagonal cases. 1.2.2. Iterative methods: Jacobi, Seidel -Gauss; (sparse matrices case). Study of convergence. 1.2.4. The calculus of a determinant and an inverse of a matrix. 1.2.4.1. Chio method. 1.2.4.2. Gauss method. 1.2.4.3. LR factorization method. 1.2.4.4. Gauss and iterative methods for the calculus of an inverse of a matrix. 1.3 Numerical methods for solving nonlinear systems. 1.3.1 Newton methods for numerical solving of nonlinear equations and systems of nonlinear equations. Study of convergence. 1.3.2 Modified Newton method for numerical resolution of systems of nonlinear equations. 1.3.3 Bairstow method for numerical resolution of algebraic equations. 1.4. Determination of the characteristic polynomial, the eigenvalues and the eigenvectors 1.4.1. Diagonal minors method. 1.4.2. LeVerrier method. 1.4.3. Krylov method (the possibily to determine the eigenvectors) 1.4.4. Fadeev method (the possibility to determine the inverse of the matrix) 1.4.5. Danilevski method (the possibility to determine the eigenvectors) 1.4.6. LR method to determine the eigenvalues and the eigenvectors. 1.4.7. Newton like iterative method for the estimation of the extreme eigenvalues of a real symmetric matrix	**10**	The main method of providing information for knowledge is through lectures and supporting material on the blackboard. To assist the students in assimilating this knowledge we use different means, like debate, exposition, exemplification, dialogue. The structure of the course takes into consideration the fact that 70% of the activity represents a theoretical teaching and 30% of the activity represents dynamic interaction with students. As for the knowledge assimilated during their private study, we provide a support of the course and we also offer additional information and references (printed and/or electronically).
Ch. 2 Function approximation 2.1. Interpolation on simple and multiple nodes. 2.1.1. Lagrange interpolating polynomial. Error minimization. 2.1.2. Newton interpolating polynomial. Error minimization. 2.1.3. Hermite interpolating polynomial. 2.1.3. Cubic spline interpolation. 2.1.4. Least squares approximation.	**6**	
Ch. 3 Numerical methods for integral approximation. 3.1 Evaluation of simple integrals. 3.1.1. Numerical approximation on two knots (trapeze formula). 3.1.2. Numerical approximation on three knots (Simpson formula). 3.1.3. Numerical approximation on four knots (Newton formula). 3.2. Evaluation of double integrals on convex domains with polygonal boundary.	**4**	
Ch. 4 Numerical methods for differential equations and partial differential equations. 4.1. Differential equations of order I and higher with initial condition (Euler, Runge-Kutta methods) 4.2. Differential ordinary equations with bi-local conditions (Sturm-Liouville problem). 4.3 Finite difference operators; types of partial differential equations of order two. 4.4. Partial differential equations of order two: elliptic type; finite difference method.	**8**	

Bibliography [8]

1. Ascher U., Greif C., A First Course in Numerical Methods (Computational Science and Engineering), SIAM, 2011
2. Burden R. L., Faires J. D., Numerical Analysis, Brooks Cole Ed., 2004
3. C de Boor, A practical guide to splines, 2nd ed. Springer, New York, 2000
4. Chatelin F., Spectral approximation of linear operators, Academic Press, New York, 1983
5. Hoffman J., Frankel S., Numerical Methods for Engineers and Scientists, Second Edition, Marcel Dekker, Inc., 2001
6. Ebâncă D., Metode numerice in algebră, Editura Sitech, Craiova, 2005
7. Mihoc Gh., Micu N., Teoria probabilităţilor si statistică matematică, E. D.P., Bucuresti, 1980
8. Militaru R., Méthodes Numériques. Théorie et Applications, Ed. Sitech, Craiova, 2008
9. Philips G., Taylor T., Theory and Applications of Numerical Analysis, Academic Press, 1999
10. Popa M., Militaru R., Analiză Numerică, Note de curs, Ed. Sitech, Craiova, 2003
11. Popa M., Militaru R., Metode numerice - algoritmi şi aplicaţii, Ed. Sitech, Craiova, 2007

8.2 Practical activities (topics/homework)	No hours	Teaching methods
1. Resolution of systems of linear equations: Gauss method, LR factorization method (Doolitle, Cholesky), iterative methods (Jacobi and Seidel-Gauss).	**6**	Most of the work is done on the computer. The algorithms developped during the course are implemented as computer programs. In order to help the students to develop the necessary skils, we use several methods such as exercising, discussions, brainstorming, debate. Laboratory platforms (containing the abstract of the theory and the algorithms) are at the disposal of the students.
2. The calculus of a determinant and of the inverse of a matrix (Gauss method, Chio method, iterative method).	**2**	
3. Characteristic polynomial, eigenvalues and eigenvectors (diagonal minors method, Fadeev method, LeVerrier method, Krylov method, LR method, Danilevski method). Resolution of nonlinear equations.	**4**	
4. Lagrange interpolating polynomial, Newton interpolating polynomial, Hermite interpolating polynomial; Cubic spline interpolation. Least square approximation.	**4**	
5. Numerical evaluation of simple integrals (trapeze method, Simpson method, Newton method). Numerical evaluation of double integrals.	**4**	
6. Differential ordinary equations: Euler method, Runge- Kutta methods; systems of differential ordinary equations.	**4**	
7. Partial differential equations – elliptic type. Finite difference method.	**2**	
8. Evaluation	**2**	

Bibliography [8]

1. Hoffman J., Frankel S., Numerical Methods for Engineers and Scientists, Second Edition, Marcel Dekker, Inc., 2001
2. Popa M., Militaru R., Metode numerice in pseudocod. Aplicatii, Ed. Sitech, Craiova, 2013

9. COURSE CONTENT CONJUNCTION WITH EXPECTATIONS OF THE EPISTEMIC COMMUNITY REPRESENTATIVES, PROFESSIONAL ASSOCIATIONS AND EMPLOYEE REPRESENTATIVES IN THE PROGRAM DOMAIN

By following this course, the students acquire and develop various concepts, methods and modern mathematical techniques, utilized in the mathematical modeling and in engineering problems.

10. EVALUATION

Activity Type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Final mark weight
10.4 Course	We evaluate the ability of the students to: - understand the problem - formulate the mathematical statement of the problem - solve the problem.	**Exam: written examination** Mandatory condition in order for the students to be allowed to sustain the exam: accomplishment of all the the projects of the practical activities from the laboratory. Evaluation: written examination: 4 practical problems. Each problem will be evaluated on a scale from 1	70%

		to 10 and the written examination mark is obtained as the arithmetic mean of the marks that were obtained for the four practical problems. The written examination mark represents 70% from the final examination mark.	
10.5 Practical activities	L: - the degree of development of the practical abilities and of the capability to handle the notions, the techniques, and the numerical methods that were introduced - the ability to apply what was learned - criteria that are focused on the conscientiousness and on the interest for individual study of each student	The evaluation of the practical activities is based on the evaluation of the homework and on a final practical test using the computer. The examination mark for the practical activities represents 30% from the final examination mark and it is obtained as follows: 1/3 is provided by the evaluation of the homework and 2/3 is provided by the laboratory test.	30%
10.6 Minimum standard of performance (the minimum knowledge necessary to promote discipline and how to check the knowledge acquiring)			
- understanding of the basic notions - obtaining a minimum of 50% from the scores of all of the examinations - the calculus of the final examination mark is made by adding 70% from the mark obtained at the written examination to 30% from the mark obtained at the practical activities.			

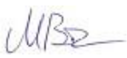
Date of completion:

Course Holder

(signature)

Applicative activities holder

(signature)



Date of approval:

Department Director

(signature)

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Notă:

1) Study level – select one of the possible choices: L (licence or undergraduate)/ M (master)/ D (doctoral).
2) Choose the code as defined by HG nr. 493/17.07.2013.
3) Type (content) - select one of the possible choices:
   - for the licence or undergraduate level: DF (fundamental discipline)/ DD (domain discipline)/ DS (specialty discipline)/ DC (complementary discipline);
   - for the master level: DA (thoroughgoing study discipline)/ DS (synthesis discipline)/ DCA (advanced knowledge discipline).
4) Condition of discipline (compulsoriness) - select one of the possible choices: DI (compulsory discipline)/ DO (optional discipline)/ FC (facultative discipline).
5) Obtained by means of adding the number of hours from 3.4 and 3.7.
6) A credit is equivalent with 25 – 30 hours of study (didactical activities and individual study).
7) The aspect of professional and transversal competences will be considered according to the OMECTS Methodology no 5703/18.12.2011. Competences are those listed in RNCIS (http://www.rncis.ro/portal/page?_pageid=117,70218&_dad=portal&_schema=PORTAL) for the field of study from 1.4 and the study program from 1.6 in which the discipline is enrolled, in this academic sheet.
8) At least one title is recommended to belong to the collective co-ordinating discipline, and at least 2-3 titles to refer relevant papers for the discipline from the national and international circuit, from the library of UCv.