University of Craiova
Department of Applied Mathematics

COURSE SYLLABUS

A. Subject Matter:	**Numerical Methods**
B. Person in charge:	Associate professor, Ph. D Romulus MILITARU
C. To whom it addresses (study program: university, license domain, specialization):	This is a course for the first year students, second semester, in the license domains COMPUTERS AND INFORMATION TECHNOLOGY (Specializations Computers in Romanian and Computers in English) and ELECTRONICAL ENGINEERING AND TELECOMUNICATION (Specialization Applied Electronics).
D. Subject's schedule (course hours, seminary, laboratory, project, number of weeks)	14 weeks; 2 hours courses/week and 2 hours laboratory /week
E. Course outcomes (expressed in the form of cognitive, technical and professional competencies)	It is one of speciality discipline which presents 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 of analysing 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 tought during the course, aiming the developpement of numerial codes and their testing on different kind of applications.
F. Assesment and evaluation	Examination: written test - Assistance: 2 internal examiners - Participation condition: Accomplishments of all laboratory duties. - Evaluation: written test: 4 practical items (each item will be appreciated from 1 to 10 points). An arithmetical average of the items will be done. - The laboratory activity: 20% of final note.
G. Prerequisites	Linear algebra, Mathematical Analysis, Differential equations, Programming.
H. Courses from study program that benefit from the course outcomes	Courses based on mathematical modelling and numerical simulation of physical and technological processes.
I. Course syllabus	Ch. 1 Numerical methods in algebra 10h 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 Ch. 2 Function approximation 6h 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. Ch. 3 Numerical methods for integral approximation. 4h 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. Ch. 4 Numerical methods for differential equations and partial differential equations. 8h 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.
J. Laboratory	1. Resolution of systems of linear equations: Gauss method, LR factorization method (Doolitle, Cholesky), iterative methods (Jacobi and Seidel-Gauss). 2. The calculus of a determinant and an inverse of a matrix (Gauss method, Chio method, iterative method). 3. Characteristic polynomial, eigenvalues and eigenvectors (diagonal minors method, Fadeev method, LeVerrier method, Krylov method, LR method, Danilevski method). Resolution of nonlinear equations. 4. Lagrange interpolating polynomial, Newton interpolating polynomial, Hermite interpolating polynomial; Cubic spline interpolation. Least square approximation. 5. Numerical evaluation of simple integrals (trapeze method, Simpson method, Newton method). Numerical evaluation of double integrals. 6. Differential ordinary equations: Euler method, Runge- Kutta methods; systems of differential ordinary equations. 7. Partial differential equations – elliptic type. Finite difference method.

K. References	1. Burden R. L., Faires J. D., *Numerical Analysis*, Brooks Cole Ed., 2004. 2. C de Boor, A *practical guide to splines*, 2nd ed. Springer, New York, 2000. 3. Ciarlet P.G., *Introduction à l'Analyse Numérique et l'Optimisation*, Ed. Masson, Paris, 1990. 4. Chatelin F., *Spectral approximation of linear operators*, Academic Press, New York, 1983. 5. Demidovici B., Maron I., *Éléments de Calcul Numérique*, Ed. Mir Moscou, 1973. 6. Ebâncă D., *Metode numerice in algebră*, Editura Sitech, Craiova, 2005. 7. Mihoc Gh., Micu N., *Teoria probabilităților 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. 11. Popa M., Militaru R., *Analiză Numerică* , Note de curs, Ed. Sitech, Craiova, 2003. 12. Popa M., Militaru R., *Metode numerice - algoritmi şi aplicații*, Ed. Sitech, Craiova, 2007.

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Signature:
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