UNIVERSITY OF CRAIOVA
Faculty of Mathematics and Computer Science
Department of mathematics
Fundamental domain : Exact sciences
Domain: Mathematics
Master: Applied mathematics
Duration of studies: 2 years
Approved with academic year 2008-2009

Numerical analysis of partial differential equations
Syllabus

Course coordinator: Prof. dr. Micu Sorin
Code: MA121
Second Cycle: MASTER
First year, Second Semester, Course 28 hours, Laboratory 28 hours
No of credits: 6
Domain: Mathematics
Type : compulsory
Category: speciality

Objectives: We introduce the main methods of approximation of the solutions of partial differential equations. We shall insist on the analysis of stability, consistence and convergence of the presented methods. Computer programs will be realized for each method.
Necessary background: Numerical analysis, Partial differential equations
Evaluation : Exam (E)

Contents:
Introduction: Main types of partial differential equations. Elliptic equations and limit conditions. Heat and wave equations. Transport equation. Convection diffusion equations.
Finite differences for elliptic equations: Finite differences. Consistence, stability and convergence of the finite differences method in 1-D and 2-D. Methods of higher order. Domains with a curve boundary.
Finite elements method for elliptic equations: Lagrange finite elements and meshes of regular domains. Approximations of elliptic equations. Cea's lemma. Convergence conditions and error estimates.
Domain decomposition and multigrid methods
Finite differences for equations of evolution: Well-posed problems. Convergence, consistence and stability. Lax's theorem. Applications.
Approximation of parabolic equations: Semi-discretization and full-discretization. Trapezoidal methods. Stability. Convergence. Fourier and energy methods. Von Neumann's analysis.
Approximation of hyperbolic equations: Semi-discretization and full-discretization. Newmark method. Stability. Convergence. Fourier and energy methods. Von Neumann's analysis.

References:

H. Brezis: *Analyse fonctionelle: Théorie et applications,* Masson, Paris, 1983.
P.G. Ciarlet: *Introduction á l'anayse numérique matricielle et à l'optimisation*, Masson, Paris, 1988.
P.G. Ciarlet: *The finite element method for eliptic problems*, North-Holland, Amsterdam, 1978.
K. Eriksson, D. Estep, P. Hansbo, C. Johnson: *Computational differential Equations*, Studentlitteratur, Lund, 1996.
S. Micu: *Introducere în metoda elementului finit*, Ed. Universitaria, Craiova, 2005.
P.A. Raviart, J.M. Thomas: *Introduction à l'analyse numérique des équations aux dérives partielles*, Masson, Paris, 1983.
P. Rabier, J.M. Thomas: *Exercices d'analyse numérique des équations aux dérivées partielles*, Masson, Paris, 1985.
J. Strickwerda: *Finite difference schemes and partial differential equations*, Pacific Grove, California, 1989.