12814 - MEF - FINITE ELEMENTS METHOD

Coordinating unit: 200 - FME - Faculty of Mathematics and Statistics
Teaching unit: 727 - MA III - Department of Applied Mathematics III
Academic year: 2008
Degree: DEGREE IN MATHEMATICS (Syllabus 1992). (Teaching unit Optative)
MASTER IN APPLIED MATHEMATICS (Syllabus 2006). (Teaching unit Optative)
MASTER IN MATHEMATICAL ENGINEERING (Syllabus 2006). (Teaching unit Optative)
DOCTORATE IN APPLIED MATHEMATICS, PLA 2005 (Syllabus 2007). (Teaching unit Optative)
ECTS credits: 6 Teaching languages: Catalonian

Lecturers

Head: VIDAL SEGUI, YOLANDA

Others: DIEZ MEJIA, PEDRO / FERNANDEZ MENDEZ, SONIA / HUERTA CEREZUELA, ANTONIO / MUÑOZ ROMERO, JOSE JAVIER

General objectives of the subject

To provide a solid theoretical and practical basis for the finite element method applied to solving PDE¿s. Emphasis is placed on tackling the most common second-order problems in engineering and in physics.
In addition to analyzing the concepts of the method, practical calculus is are also performed. Academic studies are developed for consolidating the concepts acquired, and calculus of applications to engineering enabling the power of the method to be evaluated. Attention is also paid to the techniques of adaptive remeshing based on error estimation and the application to practical calculus by finite elements.
Learn the basis of the Finite Element method, its analysis and implementation.
Experience in the use of prototype and commercial codes.

Skills to be acquired
* Familiarization with the finite element method and its applications.
* Foundations for method analysis .
* Familiarization with the use of finite element codes. Capacity for interpreting results.
* Knowledge of trends for solving PDE¿s.

Content

Introduction

Engineering and applied science problems commonly solved with the Finite Element Method.

Foundations.

Strong form, weighted residue method and weak form. Treatment of boundary conditions.
Interpolation in finite elements: mesh and splines. Numerical integration. Reference element and isoparametric transformation. Types of elements most commonly employed.

Galerkin¿s orthogonality

Review of Sobolev spaces. The Lax-Milgram theorem. Cea¿s lemma. Galerkin¿s orthogonality. A priori boundary error.

Basic algorithmics.

Efficient implementation of a finite element code.

Transitory problems.

Temprary integration techniques, modal analysis, a priori error estimators in modal decomposition.

Problems with convection.

First order hyperbolic equations. The convection-diffusion equation. Péclet¿s number. Consistent stabalization techniques.

Error estimation and adaptability.

Classification of estimators. remeshing strategies. Result-oriented estimate.

Trends in PDE numerical resolution.

Introduction to methods without mesh. Discontinuous Galerkin for first-order hyperbolic equations.

Qualification system

Based on the results from the exam, practical assignments and exercises.

12814 - MEF - FINITE ELEMENTS METHOD

Prior skills

Basic knowledge of numerical methods, differential equations and calculus.

Teaching methodology

Theory classes on the basis of the method and practical classes for acquiring expertise with the numerical tool.
* Theoretical sessions: Theoretical explanations about the basis of the method.
* Problem-solving sessions:
* Practicals: Modifications to a code prototype on MATLAB.
* Realistic cases with a professional code.

Bibliography

Basic:

Hughes,T.J.R. *The finite element method: linear static and dynamic finite element analysis.* Prentice-Hall, 1987.

Wait, R.; Mitchell, A.R.. *Finite elements analysis and applications.* Wiley, 1985.

Zienkiewicz, O.C.; Taylor, R.L.. *The finite element method.* Mc Graw-Hill, 2000.

Donea, J.; Huerta, A.. *Finite element methods for flow problems.* Wiley, 2003.

Ainsworth, M. ; Oden, J.T. *Posteriori error estimation in finite element.* Wiley, 2000.

Complementary:

Johnson, C.. *Numerical solution of partial differential equations by the finite element.* Cambridge University Press, 1990.

Strang, G.; Fix, G.J.. *An analysis of the finite element method,.* Prentice-Hall, 1973.