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Finite Element Analysis with Error Estimators

An Introduction to the FEM and Adaptive Error Analysis for Engineering Students

Elsevier This key text is written for senior undergraduate and graduate engineering students. It delivers a complete introduction to finite element methods and to automatic adaptation (error estimation) that will enable students to understand and use FEA as a true engineering tool. It has been specifically developed to be accessible to non-mathematics students and provides the only complete text for FEA with error estimators for non-mathematicians. Error estimation is taught on nearly half of all FEM courses for engineers at senior undergraduate and postgraduate level; no other existing textbook for this market covers this topic. The only introductory FEA text with error estimation for students of engineering, scientific computing and applied mathematics Includes source code for creating and proving FEA error estimators

A Posteriori Error Estimation in Finite Element Analysis

John Wiley & Sons An up-to-date, one-stop reference-complete with applications This volume presents the most up-to-date information available on aposteriori error estimation for finite element approximation inmechanics and mathematics. It emphasizes methods for ellipticboundary value problems and includes applications to incompressibleflow and nonlinear problems. Recent years have seen an explosion in the study of a posteriorierror estimators due to their remarkable influence on improvingboth accuracy and reliability in scientific computing. In an effortto provide an accessible source, the authors have sought to presentkey ideas and common principles on a sound mathematicalfooting. Topics covered in this timely reference include: * Implicit and explicit a posteriori error estimators * Recovery-based error estimators * Estimators, indicators, and hierarchic bases * The equilibrated residual method * Methodology for the comparison of estimators * Estimation of errors in quantities of interest A Posteriori Error Estimation in Finite Element Analysis is a lucidand convenient resource for researchers in almost any field offinite element methods, and for applied mathematicians andengineers who have an interest in error estimation and/or finiteelements.

On Error Estimators in Finite Element Analysis

A Posteriori Error Estimation Techniques for Finite Element Methods

Oxford University Press A posteriori error estimation techniques are fundamental to the efficient numerical solution of PDEs arising in physical and technical applications. This book gives a unified approach to these techniques and guides graduate students, researchers, and practitioners towards understanding, applying and developing self-adaptive discretization methods.

Finite Element Analysis with Error Estimation

The Mathematical Theory of Finite Element Methods

Springer Science & Business Media A rigorous and thorough mathematical introduction to the subject; A clear and concise treatment of modern fast solution techniques such as multigrid and domain decomposition algorithms; Second edition contains two new chapters, as well as many new exercises; Previous edition sold over 3000 copies worldwide

Finite Elements

An Introduction to the Method and Error Estimation

Oxford University Press Computational modelling is the process of representing some activity, for example a physical happening, first by a mathematical model and then of solving the model using a numerical technique such as the finite element method. Both parts of this process involve approximations. As a result error estimation has to be employed to assess the reliability of the computational modelling process. This book addresses the verification of the numerical methods, in thiscase finite elements methods, involved in the process, by analysing the finite element errors. The unique feature of the book is that it brings together both theoretical error analysis and the computed solutions, highlighting their interplay.

Nonlinear Finite Element Analysis in Structural Mechanics

Proceedings of the Europe-U.S. Workshop Ruhr-Universität Bochum, Germany, July 28–31, 1980

Springer Science & Business Media With the rap1d development of computational capab1lities, nonl1near f1nite element analys1s 1n structural mechan1CS has become an 1mportant field of research. Its objective is the real1stic assessment of the actual behaV10r of structures by numerical methods. Th1S requires that all nonlinear effects, such as the nonl1near character1stics of the mater1al and large deformations be taken 1nto account. The act1vities in th1S f1eld be1ng worldw1de, d1rect 1nteraction between the various research groups 1S necessary to coordinate future research and to overcome the time gap between the generat10n of new results and the1r appearance 1n the 11terature. The f1rst U.S.-Germany Sympos1um was held 1n 1976 at the Massachusetts Inst1tute of Technology. Under the general to P1C "Formulat1ons and Computat1onal Algorithms in Fin1te Ele ment Analysis" 1t prov1ded an opportun1ty for about 20 re searchers from each country to present lectures, hold discus sions, and establ1sh mutual contacts. The success of th1S first sympos1um was so encourag1ng that 1t seemed natural to organ- 1ze a second bilateral meet1ng, this time 1n Germany, and to 1nv1te researchers from other European countr1es as well.

A posteriori error estimation in finite element analysis

A Unified Approach to the Finite Element Method and Error Analysis Procedures

Elsevier A Unified Approach to the Finite Element Method and Error Analysis Procedures provides an in-depth background to better understanding of finite element results and techniques for improving accuracy of finite element methods. Thus, the reader is able to identify and eliminate errors contained in finite element models. Three different error analysis techniques are systematically developed from a common theoretical foundation: 1) modeling erros in individual elements; 2) discretization errors in the overall model; 3) point-wise errors in the final stress or strain results. Thoroughly class tested with undergraduate and graduate students. A Unified Approach to the Finite Element Method and Error Analysis Procedures is sure to become an essential resource for students as well as practicing engineers and researchers. New, simpler element formulation techniques, model-independent results, and error measures New polynomial-based methods for identifying critical points New procedures for evaluating sheer/strain accuracy Accessible to undergraduates, insightful to researchers, and useful to practitioners Taylor series (polynomial) based Intuitive elemental and point-wise error measures Essential background information provided in 12 appendices

Finite Element Analysis of Acoustic Scattering

Springer Science & Business Media A cognitive journey towards the reliable simulation of scattering problems using finite element methods, with the pre-asymptotic analysis of Galerkin FEM for the Helmholtz equation with moderate and large wave number forming the core of this book. Starting from the basic physical assumptions, the author methodically develops both the strong and weak forms of the governing equations, while the main chapter on finite element analysis is preceded by a systematic treatment of Galerkin methods for indefinite sesquilinear forms. In the final chapter, three dimensional computational simulations are presented and compared with experimental data. The author also includes broad reference material on numerical methods for the Helmholtz

equation in unbounded domains, including Dirichlet-to-Neumann methods, absorbing boundary conditions, infinite elements and the perfectly matched layer. A self-contained and easily readable work.

The Finite Element Method for Boundary Value Problems Mathematics and Computations

CRC Press Written by two well-respected experts in the field, The Finite Element Method for Boundary Value Problems: Mathematics and Computations bridges the gap between applied mathematics and application-oriented computational studies using FEM. Mathematically rigorous, the FEM is presented as a method of approximation for differential operators that are mathematically classified as self-adjoint, non-self-adjoint, and non-linear, thus addressing totality of all BVPs in various areas of engineering, applied mathematics, and physical sciences. These classes of operators are utilized in various methods of approximation: Galerkin method, Petrov-Galerkin Method, weighted residual method, Galerkin method with weak form, least squares method based on residual functional, etc. to establish unconditionally stable finite element computational processes using calculus of variations. Readers are able to grasp the mathematical foundation of finite element method as well as its versatility of applications. h-, p-, and k-versions of finite element method, hierarchical approximations, convergence, error estimation, error computation, and adaptivity are additional significant aspects of this book.

The Finite Element Method: Its Basis and Fundamentals

Elsevier The Sixth Edition of this influential best-selling book delivers the most up-to-date and comprehensive text and reference yet on the basis of the finite element method (FEM) for all engineers and mathematicians. Since the appearance of the first edition 38 years ago, The Finite Element Method provides arguably the most authoritative introductory text to the method, covering the latest developments and approaches in this dynamic subject, and is amply supplemented by exercises, worked solutions and computer algorithms. • The classic FEM text, written by the subject's leading authors • Enhancements include more worked examples and exercises • With a new chapter on automatic mesh generation and added materials on shape function development and the use of higher order elements in solving elasticity and field problems Active research has shaped The Finite Element Method into the pre-eminent tool for the modelling of physical systems. It maintains the comprehensive style of earlier editions, while presenting the systematic development for the solution of problems modelled by linear differential equations. Together with the second and third self-contained volumes (0750663219 and 0750663227), The Finite Element Method Set (0750664312) provides a formidable resource covering the theory and the application of FEM, including the basis of the method, its application to advanced solid and structural mechanics and to computational fluid dynamics. The classic introduction to the finite element method, by two of the subject's leading authors Any professional or student of engineering involved in understanding the computational modelling of physical systems will inevitably use the techniques in this key text

The Finite Element Method for Elliptic Problems

Elsevier The objective of this book is to analyze within reasonable limits (it is not a treatise) the basic mathematical aspects of the finite element method. The book should also serve as an introduction to current research on this subject. On the one hand, it is also intended to be a working textbook for advanced courses in Numerical Analysis, as typically taught in graduate courses in American and French universities. For example, it is the author’s experience that a one-semester course (on a three-hour per week basis) can be taught from Chapters 1, 2 and 3 (with the exception of Section 3.3), while another one-semester course can be taught from Chapters 4 and 6. On the other hand, it is hoped that this book will prove to be useful for researchers interested in advanced aspects of the numerical analysis of the finite element method. In this respect, Section 3.3, Chapters 5, 7 and 8, and the sections on “Additional Bibliography and Comments should provide many suggestions for conducting seminars.

Adaptive Finite Element Methods for Differential Equations

Birkhäuser These Lecture Notes have been compiled from the material presented by the second author in a lecture series ('Nachdiplomvorlesung') at the Department of Mathematics of the ETH Zurich during the summer term 2002. Concepts of 'self adaptivity' in the numerical solution of differential equations are discussed with emphasis on Galerkin finite element methods. The key issues are a posteriori er ror estimation and automatic mesh adaptation. Besides the traditional approach of energy-norm error control, a new duality-based technique, the Dual Weighted Residual method (or shortly D WR method) for goal-oriented error estimation is discussed in detail. This method aims at economical computation of arbitrary quantities of physical interest by properly adapting the computational mesh. This is typically required in the design cycles of technical applications. For example, the drag coefficient of a body immersed in a viscous flow is computed, then it is minimized by varying certain control parameters, and finally the stability of the resulting flow is investigated by solving an eigenvalue problem. 'Goal-oriented' adaptivity is designed to achieve these tasks with minimal cost. The basics of the DWR method and various of its applications are described in the following survey articles: R. Rannacher [114], Error control in finite element computations. In: Proc. of Summer School Error Control and Adaptivity in Scientific Computing (H. Bulgak and C. Zenger, eds), pp. 247-278. Kluwer Academic Publishers, 1998. M. Braack and R. Rannacher [42], Adaptive finite element methods for low Mach-number flows with chemical reactions.

Understanding and Implementing the Finite Element Method

SIAM The ?nite element method is the most powerful general-purpose technique for computing accurate solutions to partial differential equations. Understanding and Implementing the Finite Element Method is essential reading for those interested in understanding both the theory and the implementation of the ?nite element method for equilibrium problems. This book contains a thorough derivation of the finite element equations as well as sections on programming the necessary calculations, solving the finite element equations, and using a posteriori error estimates to produce validated solutions. Accessible introductions to advanced topics, such as multigrid solvers, the hierarchical basis conjugate gradient method, and adaptive mesh generation, are provided. Each chapter ends with exercises to help readers master these topics. Understanding and Implementing the Finite Element Method includes a carefully documented collection of MATLAB® programs implementing the ideas presented in the book. Readers will bene?t from a careful explanation of data structures and speci?c coding strategies and will learn how to write a ?nite element code from scratch. Students can use the MATLAB codes to experiment with the method and extend them in various ways to learn more about programming ?nite elements. This practical book should provide an excellent foundation for those who wish to delve into advanced texts on the subject, including advanced undergraduates and beginning graduate students in mathematics, engineering, and the physical sciences.Preface; Part I: The Basic Framework for Stationary Problems. Chapter 1: Some Model PDEs; Chapter 2: The weak form of a BVP; Chapter 3: The Galerkin method; Chapter 4: Piecewise polynomials and the finite element method; Chapter 5: Convergence of the finite element method; Part II Data Structures and Implementation. Chapter 6: The mesh data structure; Chapter 7: Programming the finite element method: Linear Lagrange triangles; Chapter 8: Lagrange triangles of arbitrary degree; Chapter 9: The finite element method for general BVPs; Part III: Solving the Finite Element Equations. Chapter 10: Direct solution of sparse linear systems; Chapter 11: Iterative methods: Conjugate gradients; Chapter 12: The classical stationary iterations; Chapter 13: The multigrid method; Part IV: Adaptive Methods. Chapter 14: Adaptive mesh generation; Chapter 15: Error estimators and indicators; Bibliography; Index.

The Finite Element Method for Initial Value Problems

Mathematics and Computations

CRC Press Unlike most finite element books that cover time dependent processes (IVPs) in a cursory manner, The Finite Element Method for Initial Value Problems: Mathematics and Computations focuses on the mathematical details as well as applications of space-time coupled and space-time decoupled finite element methods for IVPs. Space-time operator classification, space-time methods of approximation, and space-time calculus of variations are used to establish unconditional stability of space-time methods during the evolution. Space-time decoupled methods are also presented with the same rigor. Stability of space-time decoupled methods, time integration of ODEs including the finite element method in time are presented in detail with applications. Modal basis, normal mode synthesis techniques, error estimation, and a posteriori error computations for space-time coupled as well as space-time decoupled methods are presented. This book is aimed at a second-semester graduate level course in FEM.

A Posteriori Error Estimation for Standard Finite Element Analysis

A Posteriori Error Estimation Techniques for Finite Element Methods

OUP Oxford Self-adaptive discretization methods are now an indispensable tool for the numerical solution of partial differential equations that arise from physical and technical applications. The aim is to obtain a numerical solution within a prescribed tolerance using a minimal amount of work. The main tools in achieving this goal are a posteriori error estimates which give global and local information on the error of the numerical solution and which can easily be computed from the given numerical solution and the data of the differential equation. This book reviews the most frequently used a posteriori error estimation techniques and applies them to a broad class of linear and nonlinear elliptic and parabolic equations. Although there are various approaches to adaptivity and a posteriori error estimation, they are all based on a few common principles. The main aim of the book is to elaborate these basic principles and to give guidelines for developing adaptive schemes for new problems. Chapters 1 and 2 are quite elementary and present various error indicators and their use for mesh adaptation in the framework of a simple model problem. The basic principles are introduced using a minimal amount of notations and techniques providing a complete overview for the non-specialist. Chapters 4-6 on the other hand are more advanced and present a posteriori error estimates within a general framework using the technical tools collected in Chapter 3. Most sections close with a bibliographical remark which indicates the historical development and hints at further results.

The Finite Element Method

Fundamentals and Applications in Civil, Hydraulic, Mechanical and Aeronautical Engineering

John Wiley & Sons A comprehensive review of the Finite Element Method (FEM), this book provides the fundamentals together with a wide range of applications in civil, mechanical and aeronautical engineering. It addresses both the theoretical and numerical implementation aspects of the FEM, providing examples in several important topics such as solid mechanics, fluid mechanics and heat transfer, appealing to a wide range of engineering disciplines. Written by a renowned author and academician with the Chinese Academy of Engineering, The Finite Element Method would appeal to researchers looking to understand how the fundamentals of the FEM can be applied in other disciplines. Researchers and graduate students studying hydraulic, mechanical and civil engineering will find it a practical reference text.

Error Estimation and Adaptive Finite Element Analysis for Plane Elasticity Problems

A Feedback Finite Element Method and Some Basic Properties of the A Posteriori Error Estimation

The finite element method and some basic properties of the A posteriori error estimator

Error-controlled Adaptive Finite Elements in Solid Mechanics

John Wiley & Sons Finite Element Methods are used for numerous engineering applications where numerical solutions of partial differential equations are needed. As computers can now deal with the millions of parameters used in these methods, automatic error estimation and automatic adaptation of the utilised method (according to this error estimation), has become a hot research topic. This text offers comprehensive coverage of this new field of automatic adaptation and error estimation, bringing together the work of eight outstanding researchers in this field who have completed a six year national research project within the German Science Foundation. The result is a state-of-the-art work in true reference style. Each chapter is self-contained and covers theoretical, algorithmic and software presentations as well as solved problems. A main feature consists of several carefully elaborated benchmarks of 2D- and 3D-applications. * First book to go beyond the Finite Element Method in itself * Covers material from a new research area * Presents benchmarks of 2D- and 3D- applications * Fits with the new trend for genetic strategies in engineering

Introduction to Finite Element Analysis

Formulation, Verification and Validation

John Wiley & Sons When using numerical simulation to make a decision, how can its reliability be determined? What are the common pitfalls and mistakes when assessing the trustworthiness of computed information, and how can they be avoided? Whenever numerical simulation is employed in connection with engineering decision-making, there is an implied expectation of reliability: one cannot base decisions on computed information without believing that information is reliable enough to support those decisions. Using mathematical models to show the reliability of computer-generated information is an essential part of any modelling effort. Giving users of finite element analysis (FEA) software an introduction to verification and validation procedures, this book thoroughly covers the fundamentals of assuring reliability in numerical simulation. The renowned authors systematically guide readers through the basic theory and algorithmic structure of the finite element method, using helpful examples and exercises throughout. Delivers the tools needed to have a working knowledge of the finite element method Illustrates the concepts and procedures of verification and validation Explains the process of conceptualization supported by virtual experimentation Describes the convergence characteristics of the h-, p- and hp-methods Covers the hierarchic view of mathematical models and finite element spaces Uses examples and exercises which illustrate the techniques and procedures of quality assurance Ideal for mechanical and structural engineering students, practicing engineers and applied mathematicians Includes parameter-controlled examples of solved problems in a companion website (www.wiley.com/go/szabo)

Finite Element Analysis

CRC Press Finite element analysis has become the most popular technique for studying engineering structures in detail. It is particularly useful whenever the complexity of the geometry or of the loading is such that alternative methods are inappropriate. The finite element method is based on the premise that a complex structure can be broken down into finitely many smaller pieces (elements), the behaviour of each of which is known or can be postulated. These elements might then be assembled in some sense to model the behaviour of the structure. Intuitively this premise seems reasonable, but there are many important questions that need to be answered. In order to answer them it is necessary to apply a degree of mathematical rigour to the development of finite element techniques. The approach that will be taken in this book is to develop the fundamental ideas and methodologies based on an intuitive engineering approach, and then to support them with appropriate mathematical proofs where necessary. It will rapidly become clear that the finite element method is an extremely powerful tool for the analysis of structures (and for other field problems), but that the volume of calculations required to solve all but the most trivial of them is such that the assistance of a computer is necessary. As stated above, many questions arise concerning finite element analysis. Some of these questions are associated with the fundamental mathematical formulations, some with numerical solution techniques, and others with the practical application of the method. In order to answer these questions, the engineer/analyst needs to understand both the nature and limitations of the finite element approximation and the fundamental behaviour of the structure. Misapplication of finite element analysis programs is most likely to arise when the analyst is ignorant of engineering phenomena.

finite element methods

fifty years of the Courant element

CRC Press These proceedings originated from a conference commemorating the 50th anniversary of the publication of Richard Courant's seminal paper, Variational Methods for Problems of Equilibrium and Vibration. These papers address fundamental questions in numerical analysis and the special problems that occur in applying the finite element method to various fields of science and engineering.

Error Estimators for Vibration Analysis in 2D Elasticity

Advanced Finite Element Methods with Applications

Selected Papers from the 30th Chemnitz Finite Element Symposium 2017

Springer Finite element methods are the most popular methods for solving partial differential equations numerically, and despite having a history of more than 50 years, there is still active research on their analysis, application and extension. This book features overview papers and original research articles from participants of the 30th Chemnitz Finite Element Symposium, which itself has a 40-year history. Covering topics including numerical methods for equations with fractional partial derivatives; isogeometric analysis and other novel discretization methods, like space-time finite elements and boundary elements; analysis of a posteriori error estimates and adaptive methods; enhancement of efficient solvers of the resulting systems of equations, discretization methods for partial differential equations on surfaces; and methods adapted to applications in solid and fluid mechanics, it offers readers insights into the latest results.

Mathematical Theory of Subdivision

Finite Element and Wavelet Methods

CRC Press This book provides good coverage of the powerful numerical techniques namely, finite element and wavelets, for the solution of partial differential equation to the scientists and engineers with a modest mathematical background. The objective of the book is to provide the necessary mathematical foundation for the advanced level applications of these numerical techniques. The book begins with the description of the steps involved in finite element and wavelets-Galerkin methods. The knowledge of Hilbert and Sobolev spaces is needed to understand the theory of finite element and wavelet-based methods. Therefore, an overview of essential content such as vector spaces, norm, inner product, linear operators, spectral theory, dual space, and distribution theory, etc. with relevant theorems are presented in a coherent and accessible manner. For the graduate students and researchers with diverse educational background, the authors have focused on the applications of numerical techniques which are developed in the last few decades. This includes the wavelet-Galerkin method, lifting scheme, and error estimation technique, etc. Features: • Computer programs in Mathematica/Matlab are incorporated for easy understanding of wavelets. • Presents a range of workout examples for better comprehension of spaces and operators. • Algorithms are presented to facilitate computer programming. • Contains the error estimation techniques necessary for adaptive finite element method. This book is structured to transform in step by step manner the students without any knowledge of finite element, wavelet and functional analysis to the students of strong theoretical understanding

who will be ready to take many challenging research problems in this area.

The Essentials of Finite Element Modeling and Adaptive Refinement

Momentum Press Finite Element Analysis is a very popular, computer-based tool that uses a complex system of points called nodes to make a grid called a "mesh. " The mesh contains the material and structural properties that define how the structure will react to certain loading conditions, allowing virtual testing and analysis of stresses or changes applied to the material or component design. This groundbreaking text extends the usefulness of finite element analysis by helping both beginners and advanced users alike. It simplifies, improves, and extends both the finite element method while at the same time advancing adaptive refinement procedures. These improvements are made possible due to a change in notation that embeds knowledge of solid continuum mechanics into the equations used to formulate the stiffness matrices; this allows the modeling characteristics of individual elements to be identified by visual inspection. The ability to visually relate the equations involved in element formulation to the physical process they represent is like having an x-ray of the inner workings of the finite element method; it is similar is to the effect that Graphical User Interfaces or GUI's had on computing. As a result, students at any level of finite element study are provided with an understanding of the capabilities and limitations of this powerful analytic tool. The book presents * A more simplified approach to finite element analysis based on computational continuum mechanics * Physically interpretable notation that identifies a common basis for the finite element and the finite difference methods. * New point-wise error estimators that identify errors in terms of quantities of direct interest in solid mechanics

Finite Element Analysis Concepts

Via SolidWorks

World Scientific Young engineers are often required to utilize commercial finite element software without having had a course on finite element theory. That can lead to computer-aided design errors. This book outlines the basic theory, with a minimum of mathematics, and how its phases are structured within a typical software. The importance of estimating a solution, or verifying the results, by other means is emphasized and illustrated. The book also demonstrates the common processes for utilizing the typical graphical icon interfaces in commercial codes. in particular, the book uses and covers the widely utilized SolidWorks solid modeling and simulation system to demonstrate applications in heat transfer, stress analysis, vibrations, buckling, and other fields. The book, with its detailed applications, will appeal to upper-level undergraduates as well as engineers new to industry.

Error Estimation and Adaptivity of Spatial Discretization in Semidiscrete Finite Element Analysis for Dynamic Problems

TEXTBOOK OF FINITE ELEMENT ANALYSIS

PHI Learning Pvt. Ltd. Designed for a one-semester course in Finite Element Method, this compact and well-organized text presents FEM as a tool to find approximate solutions to differential equations. This provides the student a better perspective on the technique and its wide range of applications. This approach reflects the current trend as the present-day applications range from structures to biomechanics to electromagnetics, unlike in conventional texts that view FEM primarily as an extension of matrix methods of structural analysis. After an introduction and a review of mathematical preliminaries, the book gives a detailed discussion on FEM as a technique for solving differential equations and variational formulation of FEM. This is followed by a lucid presentation of one-dimensional and two-dimensional finite elements and finite element formulation for dynamics. The book concludes with some case studies that focus on industrial problems and Appendices that include mini-project topics based on near-real-life problems. Postgraduate/Senior undergraduate students of civil, mechanical and aeronautical engineering will find this text extremely useful; it will also appeal to the practising engineers and the teaching community.

The Finite Element Method Set

Elsevier The sixth editions of these seminal books deliver the most up to date and comprehensive reference yet on the finite element method for all engineers and mathematicians. Renowned for their scope, range and authority, the new editions have been significantly developed in terms of both contents and scope. Each book is now complete in its own right and provides self-contained reference; used together they provide a formidable resource covering the theory and the application of the universally used FEM. Written by the leading professors in their fields, the three books cover the basis of the method, its application to solid mechanics and to fluid dynamics. * This is THE classic finite element method set, by two the subject's leading authors * FEM is a constantly developing subject, and any professional or student of engineering involved in understanding the computational modelling of physical systems will inevitably use the techniques in these books * Fully up-to-date; ideal for teaching and reference

Computer-based Analysis of Error Estimation and Superconvergence in Finite Element Computations

Finite Element A Posteriori Error Estimation for Heat Conduction

Error Estimates for H-adaptive Finite Element Analysis

Adaptive H-p Finite Element Methods for the Numerical Simulation of Crack Propagation

The goal of this work is to develop robust schemes for the simulation of crack propagation using adaptive finite element analysis. Here we address the main problem of estimation of the error in the engineering quantity of interest (e.g., stress intensity factors for the crack, the stresses in the hot spots). We showed that the error in the quantity of interest can be estimated by employing the standard error estimators, for the energy norm of the error, which are existing in several commercial finite element programs. We have developed a computer based approach for checking the quality of the error estimators used in practice and we have also developed error estimators which are robust for meshes used in engineering practice. This work has led to an innovative approach for adaptive mesh refinement to obtain the quantity of interest with prescribed tolerance.

Multiscale a Posteriori Error Estimation and Mesh Adaptivity for Reliable Finite Element Analysis

Adaptive Shell Finite Element Analysis

Error Estimation for Doubly Curved Shell Element Based on Stress Projection Techniques