Thin Plates And Shells Theory Analysis And Applications

This account of the theory of plates and shells is written primarily as a textbook for graduate students in mechanical and civil engineering. The unified treatment of shells of arbitrary shape is accomplished by tensor analysis. This useful tool is introduced in the first chapter, and no knowledge of advanced mathematical methods is required. The general theory developed in the first eight chapters is applied in the remaining part to thin elastic plates and shells with special emphasis on engineering methods and engineering applications. A number of detailed examples illustrate the theory.

Plates and shells play an important role in structural, mechanical, aerospace and manufacturing applications. The theory of plates and shells have advanced in the past two decades to handle more complicated problems that were previously beyond reach. In this book, the most recent advances in this area of research are documented. These include topics such as thick plate and shell analyses, finite rotations of shell structures, anisotropic thick plates, dynamic analysis, and laminated composite panels. The book is divided into two parts. In Part I, emphasis is placed on the theoretical aspects of the analysis of plates and shells, while Part II deals with modern applications. Numerous eminent researchers in the various areas of plate and shell analyses have contributed to this work which pays special attention to aspects of research such as theory, dynamic analysis, and composite plates and shells.

This exciting text is written primarily for professional engineers interested in designing plate and shell structures. It covers basic aspects of theories and gives examples for the design of components due to internal and external loads as well as other loads such as wind and dead loads. Various derivations are kept relatively simple and the resultant equations are simplified to a level where the engineer may apply them directly to design problems. More elaborate derivations and more general equations may be found in the literature for those interested in a more in-depth knowledge of the theories of plates and shells. COMPLETE CONTENTS Bending of simply supported rectangular plates Bending of various rectangular plates Bending of circular plates Plates of various shapes and properties Approximate analysis of plates Buckling of plates Vibration of plates Membrane theory of shells of revolution Various applications of the membrane theory Bending of thin cylindrical shells due to axisymmetric loads, Various structures Buckling of cylindrical shells Buckling of shells of revolution Vibration of shells Basic finite element equations. The examples given throughout Design of Plate and Shell Structures are intended to show the engineer the level of analysis needed to achieve a safe design based on a given required degree of accuracy. The book is also appropriate for advanced engineering courses.

Extended Finite Element Method provides an introduction to the extended finite element method (XFEM), a novel computational method which has been proposed to solve complex crack propagation problems. The book helps readers understand the method and make effective use of the XFEM code and software plugins now available to model and simulate these complex problems. The book explores the governing equation behind XFEM, including level set method and enrichment shape function. The authors outline a new XFEM algorithm based on the continuum-based shell and consider numerous practical problems, including planar discontinuities, arbitrary crack propagation in shells and dynamic response in 3D composite materials. Authored by an expert team from one of China's leading academic and research institutions Offers complete coverage of XFEM, from fundamentals to applications, with numerous examples Provides the understanding needed to effectively use the latest XFEM code and software tools to model and simulate dynamic crack problems

Noted for its practical, student-friendly approach to graduate-level mechanics, this volume is considered one of the top references—for students or professioals—on the subject of elasticity and stress in construction. The author presents many examples and applications to review and support several foundational concepts. The more advanced concepts in elasticity and stress are analyzed and introduced gradually, accompanied by even more examples and engineering applications in addition to numerous illustrations.Chapter problems are carefully arranged from the basic to the more challenging. The author covers computer methods, including FEA and computational/equation-solving software, and, in many cases, classical and numerical/computer approaches.

For the first time, the Micropolar Theory of Elasticity is applied to solving a wide variety of problems connected to the specifics of nanomaterials. Namely, their unique physical-mechanical characteristics and behaviors under various stress-induced conditions. These theories have been constructed based on the equations of the classical theory of elasticity as well as other equations that have till now remained untouched in their application to molecular theories of solid deformable media. The book also introduces a new applied micropolar theory of thin shells which is based on Cosserat's pseudo-continuum. It explores the theory’s application to a category of nanomaterial shells and plates previously neglected from classical theories due to their unconventional size and structure. Theoretical results are accompanied by solutions of certain problems, essential for various applications. The book consists of six chapters. The first chapter is a review of the essential data on the non-symmetric theory of elasticity. The second and third chapters are devoted to various theories of plate bending and solutions to some basic problems. Chapter four refers to membrane or, so-called, momentary shell theory. Chapter five deals with the theory of very shallow shells. Finally, chapter six presents the geometry of the nonlinear theory of plates and the theory of very shallow shells. The book is intended for researchers, postgraduate students, and engineers, interested in the design of structures from nanomaterials and in the problems of mechanics of deformable bodies, theories

of shells and plates, and their applications in micromechanics.
Shells and plates have been widely studied by engineers during the last fifty years. As a matter of fact an important number of papers have been based on analytical calculations. More recently numerical simulations have been extensively used. for instance for large displacement analysis. for shape optimization or even -in linear analysis -for composite material understanding. But all these works lie on a choice of a finite element scheme which contains usually three kinds of approximations: 1. a plate or shell mndel including smnll parameters associated to the thickness, 2. an approximntion of the geometry (the medium sUrface of a shell and its boundary), 3. afinite element scheme in order to solve the mndel chosen. VI Obviously the conclusions that we can draw are very much depending on the quality of the three previous choices. For instance composite laminated plates with damage like a delamination is still an open problem even if interesting papers have already been published and based on numerical simulation using existing fmite element and even plate models. • In our opinion the understanding of plate modelling is still an area of interest. Furthermore the links between the various models have to be handled with care. The certainly best understood model is the Kirchhoff-Love model which was completely justified by P. O. Ciarlet and Ph. Destuynder in linear analysis using asymptotic method. But the conclusion is not so clear as far as large displacements are to be taken into account.
This book is concerned with the general theory of finite deflections of thin elastic plates and shells. The nature of the governing equations is such that deflections are essentially limited to several times the plate or shell thickness, in the spirit of the usual von Karman approximation. Finite deflections of laterally loaded rectangular plates with various edge conditions are treated in detail. The postbuckling behavior of ordinary and rib-stiffened rectangular plates subject to in-plane loads is also examined. The finite deflections of circular plates subject to axisymmetric lateral or in-plane loads are examined. Finite deflections of shallow shells in the form of curved panels subject to lateral load are studied on the basis of an approximate shell theory. The postbuckling behavior of cylindrical panels subject to various in-plane normal and shear forces is treated in detail. The finite-deflection buckling of circular cylindrical shells subject to axial compression, lateral loads, or torsion is examined with a consideration of the effects of initial geometric imperfections. Lastly, the finite-deformation buckling of spherical shells and spherical caps is treated by an approximate shell theory. The approximate theories are correlated with available experimental evidence wherever possible. (Author).
Thin Plates and ShellsTheory: Analysis, and ApplicationsCRC Press
Plate and Shell Structures: Selected Analytical and Finite Element Solutions Maria Radwa?ska, Anna Stankiewicz, Adam Wosatko, Jerzy Pamin Cracow University of Technology, Poland Comprehensively covers the fundamental theory and analytical and numerical solutions for different types of plate and shell

structures Plate and Shell Structures: Selected Analytical and Finite Element Solutions not only provides the theoretical formulation of fundamental problems of mechanics of plates and shells, but also several examples of analytical and numerical solutions for different types of shell structures. The book contains advanced aspects related to stability analysis and a brief description of modern finite element formulations for plates and shells, including the discussion of mixed/hybrid models and locking phenomena. Key features: 52 example problems solved and illustrated by more than 200 figures, including 30 plots of finite element simulation results. Contents based on many years of research and teaching the mechanics of plates and shells to students of civil engineering and professional engineers. Provides the basis of an intermediate-level course on computational mechanics of shell structures. The book is essential reading for engineering students, university teachers, practitioners and researchers interested in the mechanics of plates and shells, as well as developers testing new simulation software.

Astronomical Optics and Elasticity Theory provides a very thorough and comprehensive account of what is known in this field. After an extensive introduction to optics and elasticity, the book discusses variable curvature and multimode deformable mirrors, as well as, in depth, active optics, its theory and applications. Further, optical design utilizing the Schmidt concept and various types of Schmidt correctors, as well as the elasticity theory of thin plates and shells are elaborated upon. Several active optics methods are developed for obtaining aberration corrected diffraction gratings. Further, a weakly conical shell theory of elasticity is elaborated for the aspherization of grazing incidence telescope mirrors. The very didactic and fairly easy-to-read presentation of the topic will enable PhD students and young researchers to actively participate in challenging astronomical optics and instrumentation projects.

This is the first book devoted to a systematic description of the linear theory of piezoelectric shells and plates theory. The book contains two parts. In the first part, the theories for electroelastic thin-walled elements of arbitrary form with different directions of preliminary polarization are presented in an easy form for practical use. The approximate methods for integrating the equations of piezoelectric shells and plates are developed and applied for solving some engineering problems. In the second part, the theory of piezoelectric shells and plates is substantiated by the asymptotic method. The area of applicability for different kinds of electroelastic shell theories is studied. A new problem concerning the electroelastic phenomena at the edge of a thin-walled element is raised and solved. The Theory of Piezoelectric Shells and Plates will be valuable to researchers working in the field of electroelasticity as well as to electrical and electronic engineers who use thin-walled piezoelements. It is also be helpful for students and post-graduates specializing in mechanics and for scientists concerning asymptotic methods.

"Flow-induced vibrations due to unsteady flow often occur in many engineering areas. A specific type of unsteady flow is represented by oscillatory and pulsatile flows, which are prevalent in industrial and biological systems; applications include pump and valve operations in pipeline systems as well as blood circulation. Associated to pulsatility, wave propagation in elastic tubes is recognized as the fundamental principle of the pressure pulse in arteries. This propagation phenomenon is due to the fluid-structure interaction and not to fluid compressibility. The pulse wave velocity is related to the underlying vessel wall stiffness. In biomechanics and vascular surgery, thin-walled shell theory can be applied to model the mechanics of veins, arteries, pulmonary passages, and artificial blood vessels. This thesis focuses on the development of a new theoretical framework able to reproduce the nonlinear dynamic response of shells and plates to axial pulsatile flow. The flow is set in motion by a pulsatile pressure gradient. Coupled fluid-structure Lagrange equations of motion for a non-material volume subject to pulsatile flow and pressure with and without wave propagation are obtained and presented for the first time in the literature. The studied systems are represented by a plate periodically supported and a circular cylindrical shell with flexible boundary conditions. The fluid model is based on the potential flow theory. Numerical bifurcation analysis and time integration methods are employed to investigate the stability of the systems described using a refined reduced order model. The plate is modeled based on the von Kármán nonlinear plate theory and it is assumed to be periodically simply supported in both in-plane directions with immovable edges. The flow channel is bounded by a rigid wall. The effects on the dynamics of the plate of different system parameters such as flow velocity, pulsation amplitude, pulsation frequency, and channel pressurization are fully discussed. In vascular surgery, artificial blood vessels used for repairing and replacing damaged thoracic aorta in cases of aneurysm, dissection or coarctation can be modeled as thin-walled shells conveying pulsating flow. For this purpose, in this study, isotropic and orthotropic circular cylindrical shells with mechanical properties of woven Dacron thoracic prostheses are modeled using the nonlinear Novozhilov shell theory. A pulsatile time-dependent blood flow model is considered by applying physiological waveforms of velocity and pressure during the heart beating period. The fluid is assumed to be Newtonian and the pulsatile flow is formulated using a hybrid model that contains the unsteady effects obtained from the linear potential flow theory and the pulsatile viscous effects obtained from the unsteady time-averaged Navier-Stokes equations. Geometrically nonlinear vibrations displaying interesting and intricate nonlinear dynamics (chaos, amplitude modulation and period-doubling bifurcation) are presented via frequency-response curves, time histories, bifurcation diagrams, and Poincaré maps. This study provides an efficient fluid-structure interaction model that can reveal important aspects on the nonlinear dynamics and stability of systems conveying pulsatile flow. It also addresses a crucial but still unexplored issue in cardiovascular surgery related to the dynamics of Dacron vascular grafts subject to physiological pulsatile blood

flow. An innovative formulation of the three-dimensional quasi-linear viscoelasticity is presented and applied to fit original experimental data of relaxation in axial and circumferential directions of a woven Dacron aortic graft. Experimental dynamic tests have been conducted on a Dacron prosthesis pressurized with a blood analog fluid. Modal damping values and natural frequencies have been estimated by experimental modal analysis. Numerical simulations and comparisons with experimental results are reported." --
Presenting recent principles of thin plate and shell theories, this book emphasizes novel analytical and numerical methods for solving linear and nonlinear plate and shell dilemmas, new theories for the design and analysis of thin plate-shell structures, and real-world numerical solutions, mechanics, and plate and shell models for engineering appli

This book focuses on nonlinear finite element analysis of thin-walled smart structures integrated with piezoelectric materials. Two types of nonlinear phenomena are presented in the book, namely geometrical nonlinearity and material nonlinearity. Geometrical nonlinearity mainly results from large deformations and large rotations of structures. The book discusses various geometrically nonlinear theories including von Kármán type nonlinear theory, moderate rotation nonlinear theory, fully geometrically nonlinear theory with moderate rotations and large rotation nonlinear theory. The material nonlinearity mainly considered in this book is electroelastic coupled nonlinearity resulting from large driving electric field. This book will be a good reference for students and researchers in the field of structural mechanics.

Self-contained coverage of topics ranging from elementary theory of waves and vibrations in strings to three-dimensional theory of waves in thick plates. Over 100 problems.

This book is concerned with the general theory of finite deflections of thin elastic plates and shells. The nature of the governing equations is such that deflections are essentially limited to several times the plate or shell thickness, in the spirit of the usual von Karman approximation. Finite deflections of laterally loaded rectangular plates with various edge conditions are treated in detail. The postbuckling behavior of ordinary and rib-stiffened rectangular plates subject to in-plane loads is also examined. The finite deflections of circular plates subject to axisymmetric lateral or in-plane loads are examined. Finite deflections of shallow shells in the form of curved panels subject to lateral load are studied on the basis of an approximate shell theory. The postbuckling behavior of cylindrical panels subject to various in-plane normal and shear forces is treated in detail. The finite-deflection buckling of circular cylindrical shells subject to axial compression, lateral loads, or torsion is examined with a consideration of the effects of initial geometric imperfections. Lastly, the finite-deformation buckling of spherical shells and spherical caps is treated by an approximate shell theory. The approximate theories are correlated with available experimental evidence wherever possible.

This book includes selected papers from the ECCOMAS Thematic Conference on Multibody Dynamics, that took place in Barcelona, Spain, from June 29 to July 2, 2015. By having its origin in analytical and continuum mechanics, as well as in computer science and applied mathematics, multibody dynamics provides a basis for analysis and virtual prototyping of innovative applications in many fields of contemporary engineering. With the utilization of computational models and algorithms that classically belonged to different fields of applied science, multibody dynamics delivers reliable simulation platforms for diverse highly-developed industrial products such as vehicle and railway systems, aeronautical and space vehicles, robotic manipulators, smart structures, biomechanical systems, and nanotechnologies.

Shells and plates are critical structures in numerous engineering applications. Analysis and design of these structures is of continuing interest to the scienti c and engineering communities. Accurate and conservative assessments of the maximum load carried by a structure, as well as the equilibrium path in both the elastic and inelastic range, are of paramount importance to the engineer. The elastic behavior of shells has been closely investigated, mostly by means of the nite element method. Inelastic analysis however, especially accounting for damage effects, has received much less attention from researchers. In this book, we present a computational model for nite element, elasto-plastic, and damage analysis of thin and thick shells. Formulation of the model proceeds in several stages. First, we develop a theory for thick spherical shells, providing a set of shell constitutive equations. These equations incorporate the effects of transverse shear deformation, initial curvature, and radial stresses. The proposed shell equations are conveniently used in nite element analysis. 0 AsimpleC quadrilateral, doubly curved shell element is developed. By means of a quasi-conforming technique, shear and membrane locking are prevented. The element stiffness matrix is given explicitly, making the formulation computationally ef cient. We represent the elasto-plastic behavior of thick shells and plates by means of the non-layered model, using an Updated Lagrangian method to describe a small-strain geometric non-linearity. For the treatment of material non-linearities, we adopt an Iliushin's yield function expressed in terms of stress resultants, with isotropic and kinematic hardening rules.

Due to its easy writing style, this is the most accessible book on the market. It provides comprehensive coverage of both plates and shells and a unique blend of modern analytical and computer-oriented numerical methods in presenting stress analysis in a realistic setting. Distinguished by its broad range of exceptional visual interpretations of the solutions, applications, and means by which loads are carried in beams, plates and shells. Combining the modern-numerical, mechanics of materials, and theory of elasticity methods of analysis, it provides an in-depth and complete coverage of the subject, not explored by other texts. Its flexible organization allows instructors to more easily pick and choose topics they want to cover, depending on their course needs. Students are exposed to both the theory and the latest applications to various structural elements. Two new chapters on the fundamentals provide a stronger foundation for understanding the material. An increased emphasis on computer tools, and updated problems, examples, and references, expose students to the latest information in the field.

This book presents a hybrid approach to the mechanics of thin bodies. Classical theories of rods, plates and shells with constrained shear are based on asymptotic splitting of the equations and boundary conditions of three-dimensional elasticity. The asymptotic solutions become accurate as the thickness decreases, and the three-dimensional fields of stresses and displacements can be determined. The analysis includes practically important effects of electromechanical coupling and material inhomogeneity. The extension to the geometrically nonlinear range uses the direct approach based on the principle of virtual work. Vibrations and buckling of pre-stressed structures are studied with the help of linearized incremental formulations, and direct tensor calculus rounds out the list of analytical techniques used throughout the book. A novel theory of thin-walled rods of open profile is subsequently developed from the models of rods and shells, and traditionally applied equations are proven to be asymptotically exact. The influence of pre-stresses on the torsional stiffness is shown to be crucial for buckling analysis. Novel finite element schemes for classical rod and shell structures are presented with a comprehensive discussion regarding the theoretical basis, computational aspects and implementation details. Analytical conclusions and closed-form solutions of particular problems are validated against numerical results. The majority of the simulations were performed in the Wolfram Mathematica environment, and the compact source code is provided as a substantial and integral part of the book.

The increasing use of composite materials requires a better understanding of the behavior of laminated plates and shells. Large displacements and rotations, as well as shear deformations, must be included in the analysis. Since linear theories of shells and plates are no longer adequate for the analysis and design of composite structures, more refined theories are now used for such structures. This text develops, in a systematic manner, the overall concepts of the nonlinear analysis of shell structures. The authors start with a survey of theories for the analysis of plates and shells with small deflections and then lead to the theory of shells undergoing large deflections and rotations applicable to elastic laminated anisotropic materials. Subsequent chapters are devoted to the finite element solutions and include test case comparisons. The book is intended for graduate engineering students and stress analysts in aerospace, civil, or mechanical engineering.

This volume features the proceedings from the Summer Seminar of the Canadian Mathematical Society held at Universite Laval. The purpose of the seminar was to gather both mathematicians and engineers interested in the theory or application of plates and shells, or more generally, in the modelisation of thin structures. From this, it was hoped that a better understanding of the problem would emerge for both groups of professionals. New aspects from the mathematical point of view and new applications posing new challenges are reported. This volume offers a snapshot of the state of the art of this rapidly evolving topic.

This monograph is devoted to nonlinear dynamics of thin plates and shells with thermosensitive excitation. Because of the variety of sizes and types of mathematical models in current use, there is no prospect of solving them analytically. However, the book emphasizes a rigorous mathematical treatment of the obtained differential equations, since it helps efficiently in further developing of various suitable numerical algorithms to solve the stated problems.

The study ofthree-dimensional continua has been a traditional part of graduate education in solid mechanics for some time. With rational simplifications to the three-dimensional theory of elasticity, the engineering theories of medium-thin plates and of thin shells may be derived and applied to a large class of engi neering structures distinguished by a characteristically small dimension in one direction. Often, these theories are developed somewhat independently due to their distinctive geometrical and load-resistance characteristics. On the other hand, the two systems share a common basis and might be unified under the classification of Surface Structures after the German term Fliichentragwerke. This common basis is fully exploited in this book. A substantial portion of many traditional approaches to this subject has been devoted to constructing classical and approximate solutions to the governing equations of the system in order to proceed with applications. Within the context of analytical, as opposed to numerical, approaches, the limited general ity of many such solutions has been a formidable obstacle to applications involving complex geometry, material properties, and/or loading. It is now relatively routine to obtain computer-based solutions to quite complicated situations. However, the choice of the proper problem to solve through the selection of the mathematical model remains a human rather than a machine task and requires a basis in the theory of the subject.

Plate and shell theories experienced a renaissance in recent years. The potentials of smart materials, the challenges of adaptive structures, the demands of thin-film technologies and more on the one hand and the availability of newly developed mathematical tools, the tremendous increase in computer facilities and the improvement of commercial software packages on the other caused a reanimation of the scientific interest. In the present book the contributions of the participants of the EUROMECH Colloquium 444 "Critical Review of the Theories of Plates and Shells and New Applications" have been collected. The aim was to discuss the common roots of different plate and shell approaches, to review the current state of the art, and to develop future lines of research. Contributions were written by scientists with civil and mechanical engineering as well as mathematical and physical background.

Shell-type structures can be found almost everywhere. They appear in natural forms but also as man-made, load-bearing components in diverse engineering systems. Mankind has struggled to replicate nature’s optimization of such structures but using modern computational tools it is now possible to analyse, design and optimise them systematically. Analysis and Optimization of Prismatic and Axisymmetric Shell Structures features: comprehensive coverage of the background theory of shell structures; development and implementation of reliable, creative and efficient computational tools for static and free-vibration analysis and structural optimization of variable-thickness shells and folded-plate structures; integrated computer-aided curve and surface modelling tools and automatic mesh generation, structural analysis sensitivity analysis and mathematical programming methods; well-documented, downloadable Fortran software for these techniques using finite element and finite strip simulations which can be readily adapted by the reader for the solution of practical problems or for use within a teaching or research environment. Written by leading experts in finite element and finite strip methods, Analysis and Optimization of Prismatic and Axisymmetric Shell Structures will be of great interest to researchers in structural mechanics and in automotive, aerospace and civil engineering as well as to designers from all fields using shell structures for their strength-per-unit-mass advantages.

Lists citations with abstracts for aerospace related reports obtained from world wide sources and announces documents that have recently been entered into the NASA Scientific and Technical Information Database.

The optimal control of flexible structures is an active area of research. The main body of work in this area is concerned with the control of time-dependent displacements and stresses, and assumes linear elastic conditions, namely linear elastic material behavior and small defor- tion. See, e. g. , [1]–[3], the collections of papers [4, 5], and references therein. On the other hand, in the present paper we consider the static optimal control of a structure made of a nonlinear elastic material and und- going large deformation. An important application is the suppression of static or quasi-static elastic deformation in flexible space structures such as parts of satellites by the use of control loads [6]. Solar rad- tion and radiation from other sources induce a temperature field in the structure, which in turn generates an elastic displacement field. The displacements must usually satisfy certain limitations dictated by the allowed working conditions of various orientation-sensitive instruments and antennas in the space vehicle. For example, a parabolic reflector may cease to be effective when undergoing large deflection. The elastic deformation can be reduced by use of control loads, which may be imp- mented via mechanically-based actuators or more modern piezoelectric devices. When the structure under consideration is made of a rubb- like material and is undergoing large deformation, nonlinear material and geometric effects must be taken into account in the analysis.

Vibrations drive many engineering designs in today's engineering environment. There has been an enormous amount of research into this area of research over the last decade. This book documents some of the latest research in the field of vibration of composite shells and plates filling a much-needed gap in the market. Laminated composite shells have many engineering applications including aerospace, mechanical, marine and automotive engineering. This book makes an ideal reference for researchers and practicing engineers alike. The first book of its kind Documents 10 years of research in the field of composite shells Many Engineering applications

Presenting recent principles of thin plate and shell theories, this book emphasizes novel analytical and numerical methods for solving linear and nonlinear plate and shell dilemmas, new theories for the design and analysis of thin plate-shell structures, and real-world numerical solutions, mechanics, and plate and shell models for engineering applications. It includes computer processes for finite difference, finite element, boundary element, and boundary collocation methods as well as other variational and numerical methods. It also contains end-of-chapter examples and problem/solution sets, a catalog of solutions for cylindrical and spherical shells, and tables of the most commonly used plates and shells.

Over the past decade or so much has been written on the various attempts to produce efficient, accurate and reliable Mindlin plate finite elements. In the late sixties, a degenerated, Mindlin-type, curved shell element was developed and subsequently many improvements in such elements have been made. Reliability and efficiency in use has always been a major objective. Degenerated shell elements have enjoyed widespread popularity despite certain potential defects, including shear and membrane lock ing behaviour and spurious mechanisms. After introducing the basic foundations of Mindlin-type elements, this book describes these defects and also gives the reasons for their occurrence. Furthermore, the author proposes an approach to overcome these defects. A series of linear benchmark tests are proposed to illustrate the performance of the assumed strain element formulations. The formula tions and applications for material non-linearity are also presented. Both isotropic and anisotropic material models are included together with the results for both static and transient dynamic analyses. Two associated programs are fully documented and provided on floppy discs with test examples. Source codes for the two associated programs are provided: one is for static analysis and the other for dynamic analysis, and the programs can be

compiled and run on either a mini or mainframe coniputer via a terminal. The author hopes that this book may provide further impetus in the important research area of plate and shell element technology.
Smart structures that contain embedded piezoelectric patches are loaded by both mechanical and electrical fields. Traditional plate and shell theories were developed to analyze structures subject to mechanical loads. However, these often fail when tasked with the evaluation of both electrical and mechanical fields and loads. In recent years more advanced models have been developed that overcome these limitations. Plates and Shells for Smart Structures offers a complete guide and reference to smart structures under both mechanical and electrical loads, starting with the basic principles and working right up to the most advanced models. It provides an overview of classical plate and shell theories for piezoelectric elasticity and demonstrates their limitations in static and dynamic analysis with a number of example problems. This book also provides both analytical and finite element solutions, thus enabling the reader to compare strong and weak solutions to the problems. Key features: compares a large variety of classical and modern approaches to plates and shells, such as Kirchhoff-Love , Reissner-Mindlin assumptions and higher order, layer-wise and mixed theories introduces theories able to consider electromechanical couplings as well as those that provide appropriate interface continuity conditions for both electrical and mechanical variables considers both static and dynamic analysis accompanied by a companion website hosting dedicated software MUL2 that is used to obtain the numerical solutions in the book, allowing the reader to reproduce the examples given as well as solve problems of their own The models currently used have a wide range of applications in civil, automotive, marine and aerospace engineering. Researchers of smart structures, and structural analysts in industry, will find all they need to know in this concise reference. Graduate and postgraduate students of mechanical, civil and aerospace engineering can also use this book in their studies. www.mul2.com
The book presents mathematical and mechanical aspects of the theory of plates and shells, applications in civil, aero-space and mechanical engineering, as well in other areas. The focus relates to the following problems:• comprehensive review of the most popular theories of plates and shells,• relations between three-dimensional theories and two-dimensional ones,• presentation of recently developed new refined plates and shells theories (for example, the micropolar theory or gradient-type theories),• modeling of coupled effects in shells and plates related to electromagnetic and temperature fields, phase transitions, diffusion, etc.,• applications in modeling of non-classical objects like, for example, nanostructures,• presentation of actual numerical tools based on the finite element approach.
The analysis of plates and shells under static and dynamic loads is of greatinterest to scientists and engineers both from the theoretical and the practical viewpoint. The Boun- dary Element Method (BEM) has some distinct advantages over domain techniques such as the Finite Difference Method (FDM) and the Finite Element Method (FEM) for a wide class of structuralanalysis problems. This is the first book to deal specifically with the analysis of plates and shells by the BEM and to cover all aspects of their behaviour, and combi- nes tutorial and state-of-the-art articles on the BEM as ap- plied to plates and shells. It aims to inform scientists and engineers about the use and the advantages of this techni- que, the most recent developments in the field and the

per- tinent literature for further study.