Mechanics Of Elastic Structures

Theory of Stability of Continuous Elastic Structures presents an applied mathematical treatment of the stability of civil engineering structures. The book's modern and rigorous approach makes it especially useful as a text in advanced engineering courses and an invaluable reference for engineers.

This book focuses on the qualitative theory in structural mechanics, an area that remains underdeveloped. The qualitative theory mainly deals with the static deformation and vibrational modes of linear elastic structures, and cover subjects such as qualitative properties and the existence of solutions. Qualitative properties belong to one type of structure, are at the system level and of clear regularity, and often result from analytical derivation and logical reasoning. As for the existence of solutions, it addresses a fundamental issue in structural mechanics, and has far-reaching implications for engineering applications. A better understanding of qualitative properties can assist in both numerical computation and experimental studies. It also promotes the development of better dynamic designs for structures. At the same time, a sound grasp of the existence of solutions and related subjects can aid in quantitative analysis, and help researchers establish the theoretical background essential to their work. This book is among the few that is dedicated exclusively to the qualitative theory in structural mechanics and systematically introduces the important and challenging area to a wide audience, including graduate students in engineering.

Through several centuries there has been a lively interaction between mathematics and mechanics. On the one side, mechanics has used mathemat ics to formulate the basic laws and to apply them to a host of problems that call for the quantitative prediction of the consequences of some action. On the other side, the needs of mechanics have stimulated the development of mathematical concepts. Differential calculus grew out of the needs of Newtonian dynamics; vector algebra was developed as a means . to describe force systems; vector analysis, to study velocity fields and force fields; and the calcul~s of variations has evolved from the energy principles of mechan ics. In recent times the theory of tensors has attracted the attention of the mechanics people. Its very name indicates its origin in the theory of elasticity. For a long time little use has been made of it in this area, but in the last decade its usefulness in the mechanics of continuous media has been widely recognized. While the undergraduate textbook literature in this country was becoming "vectorized" (lagging almost half a century behind the development in Europe), books dealing with various aspects of continuum mechanics took to tensors like fish to water. Since many authors were not sure whether their readers were sufficiently familiar with tensors~ they either added' a chapter on tensors or wrote a separate book on the subject.

Shape Sensitivity Analysis of Elastic Structures

A Primer for Finite Elements in Elastic Structures

(T. I-II). Proceedings of the Symposium on International Union of Theoretical and Applied Mechanics, Li è ge, August 23-28, 1970

Structural Mechanics with Introductions to Elasticity and Plasticity

Vibrations of Elastic Systems

Solid Mechanics

Recently, a new research stimulus has derived from the observation that soft structures, such as biological systems, but also rubber and gel, may work in a post critical regime, where elastic elements are subject to extreme deformations, though still exhibiting excellent mechanical performances. This is the realm of 'extreme mechanics', to which this book is addressed. The possibility of exploiting highly deformable structures opens new and unexpected technological possibilities. In particular, the challenge is the design of deformable and bi-stable mechanisms which can reach superior mechanical performances and can have a strong impact on several high-tech applications, including stretchable electronics, nanotube serpentines, deployable structures for aerospace engineering, cable deployment in the ocean, but also sensors and flexible actuators and vibration absorbers. Readers are introduced to a variety of interrelated topics involving the mechanics of extremely deformable structures, with emphasis on bifurcation, instability and nonlinear behavior, both in the quasi-static and dynamic regimes. Essential and up-to-date theoretical, numerical and experimental methodologies are covered, as a tool to progress towards a satisfactory modeling of the nonlinear behavior of structures.

The strain formulation in elasticity and the compatibility condition in structural mechanics have neither been understood nor have they been utilized. This shortcoming prevented the formulation of a direct method to calculate stress. We have researched and understood the compatibility condition for linear problems in elasticity and in finite element analysis. This has lead to the completion of the method of force with stress (or stress resultant) as the primary unknown. The method in elasticity is referred to as the completed Beltrami-Michell formulation (CBMF), and it is the integrated force method (IFM) in structures. The dual integrated force method (IFMD) with displacement as the primary unknown has been formulated. IFM and IFMD produce identical responses. The variational derivation of the CBMF yielded the new boundary compatibility conditions. The CBMF can be used to solve stress, displacement, and mixed boundary value problems. The IFM in structures produced high-fidelity response even with a modest finite element model. The IFM has influenced structural design considerably. A fully utilized design method for strength and stiffness limitation has been developed. The singularity condition in optimization has been identified. The CBMF and IFM tensorial approaches are robust formulations because of simultaneous emphasis on the equilibrium equation and the compatibility condition. Patnaik, Surya N. and Pai, Shantaram S. and Hopkins, Dale A. Glenn Research Center COMPATIBILITY; DESIGN OPTIMIZATION; ELASTIC PROPERTIES; MATHEMATICAL MODELS; SOLID MECHANICS; STRUCTURAL STRAIN; MECHANICAL PROPERTIES; EQUILIBRIUM EQUATIONS; FINITE ELEMENT METHOD; MICHELL THEOREM; STIFFNESS; BOUNDARY VALUE PROBLEMS; SINGULARITY (MATHEMATICS); DISPLACEMENT; POLAR COORDINATES; TEMPERATURE DISTRIBUTION; LOADS (FORCES)

A thorough guide to the fundamentals--and how to use them--of finite element analysis for elastic structures For elastic structures, the finite element method is an invaluable tool which is used most effectively only when one understands completely each of its facets. A Primer for Finite Elements in Elastic Structures disassembles the entire finite element method for civil engineering students and professionals, detailing its supportive theory and its mathematical and structural underpinnings, in the context of elastic structures and the principle of virtual work. The book opens with a discussion of matrix algebra and algebraic equation systems to foster the basic skills required to successfully understand and use the finite element method. Key mathematical concepts outlined here are joined to pertinent concepts from mechanics and structural theory, with the method constructed in terms of one-dimensional truss and framework finite elements. The use of these one-dimensional elements in the early chapters promotes better understanding of the fundamentals. Subsequent chapters describe many two-dimensional structural finite elements in depth, including the geometry, mechanics, transformations, and mapping needed for them. Most chapters end with questions and problems which review the text material. Answers for many of these are at the end of the book. An appendix describes how to use MATLAB(r), a popular matrix-manipulation software platform necessary to perform the many matrix operations required for the finite element method, such as matrix addition, multiplication, inversion, partitioning, rearrangement, and assembly. As an added extra, the m-files discussed can be downloaded from the Wiley FTP server.

An Introduction to the History of Structural Mechanics

An Introduction to the Mechanics of Elastic and Plastic Deformation of Solids and Structural Components

Mechanics of Materials Volume 1

Structures and Solid Body Mechanics

Mathematical Models for Elastic Structures

One of the most important subjects for any student of engineering to master is the behaviour of materials and structures under load. The way in which they react to applied forces, the deflections resulting and the stresses and strains set up in the bodies concerned are all vital considerations when designing a mechanical component such that it will not fail under predicted load during its service lifetime. All the essential elements of a treatment of these topics are contained within this course of study, starting with an introduction to the cor shear force and bending moments and moving on to the examination of bending, shear and torsion in elements such as beams, cylinders, shells and springs. A simple treatment of complex stress and complex strain leads to a study of the theories of elastic failure and an introduction to the experimental methods of stress and strain analysis. More advanced topics are dealt with in a companion volume - Mechanics of Materials 2. Each chapter contains a summary of the essential formulae which are developed in the chapter, and a large which progress in level of difficulty as the principles are enlarged upon. In addition, each chapter concludes with an extensive selection of problems for solution by the student, mostly examination questions from professional and academic bodies, which are graded according to difficulty and furnished with answers at the end. * Emphasis on practical learning and applications, rather than theory * Provides the essential formulae for each individual chapter * Contains numerous worked examples and problems

A popular text in its first edition, Mechanics of Solids and Structures serves as a course text for the senior/graduate (fourth or fifth year) courses/modules in the mechanics of solid/advanced strength of materials, offered in aerospace, civil, engineering science, and mechanical engineering departments. Now, Mechanics of Solid and Structure, Second Edition presents the latest developments in computational methods that have revolutionized the field, while retaining all of the basic principles and foundational information needed for mast mechanics. Key changes to the second edition include full-color illustrations throughout, web-based computational material, and the addition of a new chapter on the energy methods of structural mechanics. Using authoritative, yet accessible language, the authors explain the construction of expressions for both total potential energy and complementary potential energy associated with structures. They explore how the principles of minimal total potential energy and complementary energy provide the means to obtain governing equatio a means to determine point forces and displacements with ease using Castigliano's Theorems I and II. The material presented in this chapter also provides a deeper understanding of the finite element method, the most popular method for solving structural mechanics problems. Integrating computer techniques and programs into the body of the text, all chapters offer exercise problems for further understanding. Several appendices provide examples, answers to select problems, and opportunities for investigation into complementary to programs discussed are available on the CRC Press website.

Chronicling the 11th US–France Mechanics and physics of solids at macro- and nano-scales symposium, organized by ICACM (International Center for Applied Computational Mechanics) in Paris, June 2018, this book addresses the breadth of issues raised. It covers a comprehensive range of scientific and technological topics (from elementary plastic events in metals and materials in harsh environments to bio-engineered and bio-mimicking materials), offering a representative perspective on state-of-the-art research and materials. E related to mesoscale modeling, the first part of the book addresses the representation of plastic deformation at both extremes of the scale – between nano- and macro- levels. The second half of the book examines the mechanics and physics of soft materials, polymers and materials made from fibers or molecular networks.

Beams and Framed Structures

An Introduction to the Elastic Stability of Structures

Buckling of Elastic Structures

Mechanics of Elastic Structures

Stability of Structures

Mechanics of Elastic Structures with Inclined Members

The International Union of Theoretical and Applied Mechanics (IUTAM) initiated and supported an International Symposium on Dynamical Problems for Rigid-elastic Systems and Structures held in 1990 in Moscow, USSR. The Symposium was intended to bring together scientists working in the fields of multibody system dynamics and finite element systems with special emphasis to modeling, simulation, optimization and control. A Scientific Committee was appointed by the Bureau of IUTAM with following members: N.V. Banichuk (USSR). E.J. Haug (USA). Y. Hori (Japan). S. Kaliszky (Hungary), D.M. Klimov (USSR). Chairman, L. Lilov (Bulgaria), F. Niordson (Denmark), B. Roth (USA), W. Schiehlen (Germany), G. Schmidt (Germany), J. Wittenburg (Germany). The chairman invited the participants on recommendation by the Scientific Committee. As a result 48 active scientific participants from 11 countries followed the invitation, and 32 papers were presented in lecture sessions. The available manuscripts were reviewed by the Scientific Committee after the Symposium, and 24 of them are collected in this volume. At the Symposium a tour to the Institute for Problems of Mechanics, USSR Academy of Sciences, was arranged. The scientific lectures were devoted to the following topics: o Modeling and Optimization, o Dynamics of Systems with Elastic Constraints, o Vibrations, o Multibody Systems.

One of the most important subjects for any student of engineering or materials to master is the behaviour of materials and structures under load. The way in which they react to applied forces, the deflections resulting and the stresses and strains set up in the bodies concerned are all vital considerations when designing a mechanical component such that it will not fail under predicted load during its service lifetime. Building upon the fundamentals established in the introductory volume Mechanics of Materials 1, this book extends the scope of material covered into more complex areas such as unsymmetrical bending, loading and deflection of struts, rings, discs, cylinders plates, diaphragms and thin walled sections. There is a new treatment of the Finite Element Method of analysis, and more advanced topics such as contact and residual stresses, stress concentrations, fatigue, creep and fracture are also covered. Each chapter contains a summary of the essential formulae which are developed in the chapter, and a large number of worked examples which progress in level of difficulty as the principles are enlarged upon. In addition, each chapter concludes with an extensive selection of problems for solution by the student, mostly examination questions from professional and academic bodies, which are graded according to difficulty and furnished with answers at the end.

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Mechanics and Physics of Solids at Micro- and Nano-Scales

The Mechanics of Elastic and Plastic Deformation of Solids and Structural Materials

A Variational Approach, Augmented Edition

Theory of Stability of Continuous Elastic Structures

Strength of Materials and Theory of Elasticity in 19th Century Italy

Mechanics of Civil Engineering Structures

This work presents a unified approach to the vibrations of elastic systems as applied to MEMS devices, mechanical components, and civil structures. Applications include atomic force microscopes, energy harvesters, and carbon nanotubes and consider such complicating effects as squeeze film damping, viscous fluid loading, in-plane forces, and proof mass interactions with their elastic supports. These effects are analyzed as single degree-of-freedom models and as more realistic elastic structures. The governing equations and boundary conditions for beams, plates, and shells with interior and boundary attachments are derived by applying variational calculus to an expression describing the energy of the system. The advantages of this approach regarding the generation of orthogonal functions and the Rayleigh-Ritz method are demonstrated. A large number of graphs and tables are given to show the impact of various factors on the systems natural frequencies, mode shapes, and responses.

This book examines the theoretical foundations underpinning the field of strength of materials/theory of elasticity, beginning from the origins of the modern theory of elasticity. While the focus is on the advances made within Italy during the nineteenth century, these achievements are framed within the overall European context. The vital contributions of Italian mathematicians, mathematical physicists and engineers in respect of the theory of elasticity, continuum mechanics, structural mechanics, the principle of least work and graphical methods in engineering are carefully explained and discussed. The book represents a work of historical research that primarily comprises original contributions and summaries of work published in journals. It is directed at those graduates in engineering, but also in architecture, who wish to achieve a more global and critical view of the discipline and will also be invaluable for all scholars of the history of mechanics.

This book is one of the finest I have ever read. To write a foreword for· it is an honor, difficult to accept. Everyone knows that architects and master masons, long before there were mathematical theories, erected structures of astonishing originality, strength, and beauty. Many of these still stand. Were it not for our now acid atmosphere, we could expect them to stand for centuries more. We admire early architects' visible success in the distribution and balance of thrusts, and we presume that master masons had rules, perhaps held secret, that enabled them to turn architects' bold designs into reality. Everyone knows that rational theories of strength and elasticity, created centuries later, were influenced by the wondrous buildings that men of the sixteenth, seventeenth, and eighteenth centuries saw daily. Theorists know that when, at last, theories began to appear, architects distrusted them, partly because they often disregarded details of importance in actual construction, partly because nobody but a mathematician could understand the aim and func tion of a mathematical theory designed to represent an aspect of nature. This book is the first to show how statics, strength of materials, and elasticity grew alongside existing architecture with its millenial traditions, its host of successes, its ever-renewing styles, and its numerous problems of maintenance and repair. In connection with studies toward repair of the dome of St. Peter's by Poleni in 1743, on p.

Analysis of Vibration, Buckling and Bending of X-Braced Frames and Conical Shells

Stability, Bifurcation and Postcritical Behaviour of Elastic Structures

Elementary Continuum Mechanics for Everyone

High Speed Computing of Elastic Structures

Qualitative Properties and Existence of Solutions

Part II: Vaulted Structures and Elastic Systems

During the seventeenth century, several useful theories of elastic structures emerged, with applications to civil and mechanical engineering problems. Recent and improved mathematical tools have extended applications into new areas such as mathematical physics, geomechanics, and biomechanics. This book offers a critically filtered collection of the most significant theories dealing with elastic slender bodies. It includes mathematical models involving elastic structures that are used to solve practical problems with particular emphasis on nonlinear problems.

The subject discussed in this book is the stability of thin-walled elastic systems under static loads. The presentation of these problems is based on modern approaches to elastic-stability theory. Special attention is paid to the formulation of elastic-stability criteria, to the statement of column, plate and shell stability problems, to the derivation of basic relationships, and to a discussion of the boundaries of the application of analytic relationships. The author has tried to avoid arcane, nonstandard problems and elaborate and unexpected solutions, which bring real pleasure to connoisseurs, but confuse students and cause bewilderment to some practical engineers. The author has an apprehension that problems which, though interesting, are limited in application can divert the reader's attention from the more prosaic but no less sophisticated general problems of stability theory.

This book provides an introduction to fundamental concepts of solid mechanics for the uninitiated. It also includes a concise review of fundamentals for those who have been away from the field for a time or are studying for a final exam or engineering license exam. The coverage ranges from fundamental definitions through constitutive equations, axial loading, torsion, bending, thermal effects, stability, pressure vessels, plates and shells, computational mechanics, and fibrous composite materials.

Extremely Deformable Structures

A Brief Account of the History of Mechanics of Solids and Structures

Asymptotic Methods for Elastic Structures

A Concise Introduction to Elastic Solids

An Introduction to the Mechanics of Elastic and Plastic Deformation of Solids and Structural Materials

Proceedings of The Symposium of International Union of Theoretical and Applied Mechanics, Held in Liege from August 23-28, 1970

This monograph presents the mechanics of vibration, buckling and bending of elastic structures with inclined members such as x-braced high rise frames and conical shells. More than giving detailed derivations of basic equations, Mechanics of Elastic Structures with Inclined Members is mainly oriented towards practical problem-solving. The book can be used as a textbook for graduate students concentrating on structural mechanics, or as a reference book for engineers and researchers in the fields of engineering mechanics, civil engineering, mechanical engineering, and aerospace engineering.

Mechanics of Elastic StructuresTaylor & Francis GroupMechanics of Elastic StructuresMechanics of Elastic Structures with Inclined MembersAnalysis of Vibration, Buckling and Bending of X-Braced Frames and Conical ShellsSpringer Science & Business Media

Solid Mechanics: A Variational Approach, Augmented Edition presents a lucid and thoroughly developed approach to solid mechanics for students engaged in the study of elastic structures not seen in other texts currently on the market. This work offers a clear and carefully prepared exposition of variational techniques as they are applied to solid mechanics. Unlike other books in this field, Dym and Shames treat all the necessary theory needed for the study of solid mechanics and include extensive applications. Of particular note is the variational approach used in developing consistent structural theories and in obtaining exact and approximate solutions for many problems. Based on both semester and year-long courses taught to undergraduate seniors and graduate students, this text is geared for programs in aeronautical, civil, and mechanical engineering, and in engineering science. The authors' objective is two-fold: first, to introduce the student to the theory of structures (one- and two-dimensional) as developed from the three-dimensional theory of elasticity; and second, to introduce the student to the strength and utility of variational principles and methods, including briefly making the connection to finite element methods. A complete set of homework problems is included.

Elastic, Inelastic, Fracture and Damage Theories

An Overview of the Mechanics of Elastic Materials and Structures

Elastostatics and Kinetics of Anisotropic and Heterogeneous Shell-Type Structures

Mechanics of Materials 2

Qualitative Theory in Structural Mechanics

Tensor Analysis and Continuum Mechanics

Beams and Framed Structures, Second Edition deals with the material strength and stiffness of beams and plane frames. The theory of structures, as applied to frames, is examined, with emphasis on bending moments throughout the frame and the resulting deformations. Linear elastic structures and plastic collapse and elastic-plastic structures are considered. Comprised of three chapters, this book begins with an introduction to the basic equations on equilibrium, deformation, virtual work, and the relationship between bending moment and curvature. The next chapter is devoted to elastic beams and frames, with particular reference to the principle of superposition; energy methods for elastic frames; moment distribution; and thermal effects. The final chapter focuses on plastic beams and frames and covers topics such as theorems of plastic collapse; elastic-plastic analysis; deflexions at collapse; and interaction diagrams. Throughout the text, it is assumed that all members of a frame remain stable, so that instability phenomena do not occur. This monograph will be of interest to structural and mechanical engineers.

Practicing engineers designing civil engineering structures, and advanced students of civil engineering, require foundational knowledge and advanced analytical and empirical tools. Mechanics in Civil Engineering Structures presents the material needed by practicing engineers engaged in the design of civil engineering structures, and students of civil engineering. The book covers the fundamental principles of mechanics needed to understand the responses of structures to different types of load and provides the analytical and empirical tools for design. The title presents the mechanics of relevant structural elements—including columns, beams, frames, plates and shells—and the use of mechanical models for assessing design code application. Eleven chapters cover topics including stresses and strains; elastic beams and columns; inelastic and composite beams and columns; temperature and other kinematic loads; energy principles; stability and second-order effects for beams and columns; basics of vibration; indeterminate elastic-plastic structures; plates and shells. This book is an invaluable guide for civil engineers needing foundational background and advanced analytical and empirical tools for structural design. Includes 110 fully worked-out examples of important problems and 130 practice problems with an interaction solution manual (http://hsz121.hsz.bme.hu/solutionmanual). Presents the foundational material and advanced theory and method needed by civil engineers for structural design Provides the methodological and analytical tools needed to design civil engineering structures Details the mechanics of salient structural elements including columns, beams, frames, plates and shells Details mechanical models for assessing the applicability of design codes

The series is aimed specifically at publishing peer reviewed reviews and contributions presented at workshops and conferences. Each volume is associated with a particular conference, symposium or workshop. These events cover various topics within pure and applied mathematics and provide up-to-date coverage of new developments, methods and applications.

Dynamical Problems of Rigid-Elastic Systems and Structures

Proceedings of the International Conference, Lisbon, Portugal, October 4-8, 1993

Mechanics of Solids and Structures, Second Edition

With Applications to MEMS and NEMS

Stability of Elastic Structures

Mathematical Theory of Elastic Structures

A comprehensive and systematic analysis of elastic structural stability is presented in this volume. Traditional engineering buckling concepts are discussed in the framework of the Liapunov theory of stability by giving an extensive review of the Koiter approach. The perturbation method for both nonlinear algebraic and differential equations is discussed and adopted as the main tool for postbuckling analysis. The formulation of the buckling problem for the most common engineering structures - rods and frames, plates, shells, and thin-walled beams, is performed and the critical load evaluated for problems of interest. In many cases the postbuckling analysis up to the second order is presented. The use of the Ritz-Galerkin and of the finite element methods is examined as a tool for approximate bifurcation analysis. The volume will provide an up-to-date introduction for non-specialists in elastic stability theory and methods, and is intended for graduate and post-graduate students and researchers interested in nonlinear structural analysis problems. Basic prerequisites are kept to a minimum, a familiarity with elementary algebra and calculus is all that is required of readers to make use of this book.

The book covers three main topics: the classical theory of linear elasticity, the mathematical theory of composite elastic structures, as an application of the theory of elliptic equations on composite manifolds developed by the first author, and the finite element method for solving elastic structural problems. The authors treat these topics within the framework of a unified theory. The book carries on a theoretical discussion on the mathematical basis of the principle of minimum potential theory. The emphasis is on the accuracy and completeness of the mathematical formulation of elastic structural problems. The book will be useful to applied mathematicians, engineers and graduate students. It may also serve as a course in elasticity for undergraduate students in applied sciences.

A crucial element of structural and continuum mechanics, stability theory has limitless applications in civil, mechanical, aerospace, naval and nuclear engineering. This text of unparalleled scope presents a comprehensive exposition of the principles and applications of stability analysis. It has been proven as a text for introductory courses and various advanced courses for graduate students. It is also prized as an exhaustive reference for engineers and researchers. The authors' focus on understanding of the basic principles rather than excessive detailed solutions, and their treatment of each subject proceed from simple examples to general concepts and rigorous formulations. All the results are derived using as simple mathematics as possible. Numerous examples are given and 700 exercise problems help in attaining a firm grasp of this central aspect of solid mechanics. The book is an unabridged republication of the 1991 edition by Oxford University Press and the 2003 edition by Dover, updated with 18 pages of end notes.

Compatibility Condition in Theory of Solid Mechanics (Elasticity, Structures, and Design Optimization)

Mechanics of Elastic Composites

IUTAM Symposium, Moscow, USSR May 23–27,1990

Mechanics of Materials

Nonlinear Mechanics of Structures

This is a comprehensive, reader-friendly treatment of the theory behind modern elastic composite materials. The treatment includes recently developed results and methods drawn from research papers published in Eastern Europe that until now were unavailable in many western countries. Among the book's many notable features is the inclusion of more than 400 problems, many of which are solved at the end of the book. Mechanics of Elastic Composites is an outstanding textbook for graduate-level course work and a valuable reference for engineers and researchers. Developed over many years by leading experts in the field, this book will remain an important contribution to the literature for years to come.

The aim of this book is to provide a unified presentation of modern mechanics of structures in a form which is suitable for graduate students as well as for engineers and scientists working in the field of applied mechanics. Traditionally, students at technical universities have been taught subjects such as continuum mechanics, elasticity, plates and shells, frames or finite element techniques in an entirely separate manner. The authors' teaching experience clearly suggests that this situation frequently tends to create in students' minds an incomplete and inconsistent picture of the contemporary structural mechanics. Thus, it is very common that the fundamental laws of physics appear to students hardly related to simplified equations of different "technical" theories of structures, numerical solution techniques are studied independently of the essence of mechanical models they describe, and so on. The book is intended to combine in a reasonably connected and unified manner all these problems starting with the very fundamental postulates of nonlinear continuum mechanics via different structural models of "engineer ing" accuracy to numerical solution methods which can effectively be used for solving boundary-value problems of technological importance. The authors have tried to restrict the mathematical background required to that which is normally familiar to a mathematically minded engineering graduate.