

Analytical Methods In Conduction Heat Transfer

The convection and conduction heat transfer, thermal conductivity, and phase transformations are significant issues in a design of wide range of industrial processes and devices. This book includes 18 advanced and revised contributions, and it covers mainly (1) heat convection, (2) heat conduction, and (3) heat transfer analysis. The first section introduces mixed convection studies on inclined channels, double diffusive coupling, and on lid driven trapezoidal cavity, forced natural convection through a roof, convection on non-isothermal jet oscillations, unsteady pulsed flow, and hydromagnetic flow with thermal radiation. The second section covers heat conduction in capillary porous bodies and in structures made of functionally graded materials, integral transforms for heat conduction problems, non-linear radiative-conductive heat transfer, thermal conductivity of gas diffusion layers and multi-component natural systems, thermal behavior of the ink, primer and paint, heating in biothermal systems, and RBF finite difference approach in heat conduction. The third section includes heat transfer analysis of reinforced concrete beam, modeling of heat transfer and phase transformations, boundary conditions-surface heat flux and temperature, simulation of phase change materials, and finite element methods of factorial design. The advanced idea and information described here will be fruitful for the readers to find a sustainable solution in an industrialized society.

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This book presents a solution for direct and inverse heat conduction problems, discussing the theoretical basis for the heat transfer process and presenting selected theoretical and numerical problems in the form of exercises with solutions. The book covers one-, two- and three dimensional problems which are solved by using exact and approximate analytical methods and numerical methods. An accompanying CD-Rom includes computational solutions of the examples and extensive FORTRAN code.

Advanced Heat Transfer, Second Edition provides a comprehensive presentation of intermediate and advanced heat transfer, and a unified treatment including both single and multiphase systems. It provides a fresh perspective, with coverage of new emerging fields within heat transfer, such as solar energy and cooling of microelectronics. Conductive, radiative and convective modes of heat transfer are presented, as are phase change modes. Using the latest solutions methods, the text is ideal for the range of engineering majors taking a second-level heat transfer course/module, which enables them to succeed in later coursework in energy systems, combustion, and chemical reaction engineering.

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This book describes useful analytical methods by applying them to real-world problems rather than solving the usual over-simplified classroom problems. The book demonstrates the applicability of analytical methods even for complex problems and guides the reader to a more intuitive understanding of approaches and solutions.

Although the solution of Partial Differential Equations by

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numerical methods is the standard practice in industries, analytical methods are still important for the critical assessment of results derived from advanced computer simulations and the improvement of the underlying numerical techniques. Literature devoted to analytical methods, however, often focuses on theoretical and mathematical aspects and is therefore useless to most engineers. *Analytical Methods for Heat Transfer and Fluid Flow Problems* addresses engineers and engineering students. The second edition has been updated, the chapters on non-linear problems and on axial heat conduction problems were extended. And worked out examples were included.

"The first chapter of this book proposes an analytical Fourier series solution to the equation for heat transfer by conduction in a spherical shell with an internal stone consisting of insulating material as a model for the kinetic of temperature in stone fruits both as a general solution and a mass average value. The chapter also considers an internal heat source linearly reliant on temperature. The second chapter focuses on the sensitivity of the numerical modeling technique for conjugate heat transfer involving high speed compressible flow over a cylinder. The last chapter presents an overview of the fundamental solution (FS) based finite element method (FEM) and its application in heat conduction problems. First, basic formulations of FS-FEM are presented, such as the nonconforming intra-element field, auxiliary conforming frame field, modified variational principle, and stiffness equation. Then, the FS-FE formulation for heat conduction problems in cellular solids with circular holes,

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functionally graded materials, and natural-hemp-fiber-filled cement composites are described"--

This innovative text emphasizes a "less-is-more" approach to modeling complicated systems such as heat transfer by treating them first as "1-node lumped models" that yield simple closed-form solutions. The author develops numerical techniques for students to obtain more detail, but also trains them to use the techniques only when simpler approaches fail. Covering all essential methods offered in traditional texts, but with a different order, Professor Sidebotham stresses inductive thinking and problem solving as well as a constructive understanding of modern, computer-based practice.

Readers learn to develop their own code in the context of the material, rather than just how to use packaged software, offering a deeper, intrinsic grasp behind models of heat transfer. Developed from over twenty-five years of lecture notes to teach students of mechanical and chemical engineering at The Cooper Union for the Advancement of Science and Art, the book is ideal for students and practitioners across engineering disciplines seeking a solid understanding of heat transfer. This book also:

- Adopts a novel inductive pedagogy where commonly understood examples are introduced early and theory is developed to explain and predict readily recognized phenomena
- Introduces new techniques as needed to address specific problems, in contrast to traditional texts' use of a deductive approach, where abstract general principles lead to specific examples
- Elucidates readers' understanding of the "heat transfer takes time" idea—transient analysis applications are

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introduced first and steady-state methods are shown to be a limiting case of those applications · Focuses on basic numerical methods rather than analytical methods of solving partial differential equations, largely obsolete in light of modern computer power · Maximizes readers' insights to heat transfer modeling by framing theory as an engineering design tool, not as a pure science, as has been done in traditional textbooks · Integrates practical use of spreadsheets for calculations and provides many tips for their use throughout the text examples

Heat Conduction, Fifth Edition, upholds its reputation as the leading text in the field for graduate students, and as a resource for practicing engineers. The text begins with fundamental concepts, introducing the governing equation of heat conduction, and progresses through solutions for one-dimensional conduction, orthogonal functions, Fourier series and transforms, and multi-dimensional problems. Integral equations, Laplace transforms, finite difference numerical methods, and variational formulations are then covered. A systematic derivation of the analytical solution of heat conduction problems in heterogeneous media, introducing a more general approach based on the integral transform method, has been added in this new edition, along with new and revised problems, and complete problem solutions for instructors.

Since its publication more than 15 years ago, Heat Conduction Using Green's Functions has become the consummate heat conduction treatise from the perspective of Green's functions-and the newly revised Second Edition is poised to take its place. Based on the

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authors' own research and classroom experience with the material, this book organizes the so

Despite the length of time it has been around, its importance, and vast amounts of research, combustion is still far from being completely understood. Environmental, cost, and fuel consumption issues add further complexity, particularly in the process and power generation industries. Dedicated to advancing the art and science of industrial combustion, *The John Zink Hamworthy Combustion Handbook, Second Edition: Volume One – Fundamentals* gives you a strong understanding of the basic concepts and theory. Under the leadership of Charles E. Baukal, Jr., top combustion engineers and technologists from John Zink Hamworthy Combustion examine the interdisciplinary fundamentals—including chemistry, fluid flow, and heat transfer—as they apply to industrial combustion. What's New in This Edition Expanded to three volumes, with Volume One focusing on fundamentals Extensive updates and revisions throughout Updated information on HPI/CPI industries, including alternative fuels, advanced refining techniques, emissions standards, and new technologies Expanded coverage of the physical and chemical principles of combustion New practices in coal combustion, such as gasification The latest developments in cold-flow modeling, CFD-based modeling, and mathematical modeling Greater coverage of pollution emissions and NO_x reduction techniques New material on combustion diagnostics, testing, and training More property data useful for the design and operation of combustion equipment Coverage of

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technologies such as metallurgy, refractories, blowers, and vapor control equipment Now expanded to three volumes, the second edition of the bestselling The John Zink Combustion Handbook continues to provide the comprehensive coverage, up-to-date information, and visual presentation that made the first edition an industry standard. Featuring color illustrations and photographs throughout, Volume One: Fundamentals helps you broaden your understanding of industrial combustion to better meet the challenges of this field. For the other volumes in the set, see The John Zink Hamworthy Combustion Handbook, Second Edition: Three-Volume Set.

Heat transfer calculations in different aspects of engineering applications are essential to aid engineering design of heat exchanging equipment. Minimizing of computational time is a challenging task faced by researchers and users. Methodology of calculations in some application areas are incorporated in this book, such as differential analysis of heat recoveries with CFD in a tube bank, heating and ventilation of equipment and methods for analytical solution of nonlinear problems. Numerical analysis is the prerequisite of design and for the manufacture of heat exchanging equipment. Some numerical and experimental information are presented with utmost skill. Similarly, the analytical solution of heat transfer is touched in this book. Study of heat transfer phenomena and applications are equally emphasized in this issue.

This volume provides a comprehensive overview on the vast amount of literature on solidification heat transfer.

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Chapter one develops important basic equations and discusses the validity of considering only conductive heat transfer, while ignoring convection, in the large class of materials which make up the porous media. Chapters 2 to 4 deal with problems that can be expressed in plane (Cartesian) coordinates. These problems are further divided into boundary conditions of temperature, prescribed heat flux, and surface convection. Chapter 5 examines some plane geometries involving three-dimensional freezing or thawing. Problems in the cylindrical and spherical coordinate systems are covered in chapters 6 and 7. Chapter 8 is an introduction to solidification in porous media. Many of the applications have been directed to water/ice soil-systems, but it should be clear that the basic techniques and solutions can be applied to such diverse areas as metallurgy, biological systems, latent heat storage, and the preservation of food.

Many phenomena in social, natural and engineering fields are governed by wave, potential, parabolic heat-conduction, hyperbolic heat-conduction and dual-phase-lagging heat-conduction equations. This monograph examines these equations: their solution structures, methods of finding their solutions under various supplementary conditions, as well as the physical implication and applications of their solutions.

This book introduces the fundamental concepts of inverse heat transfer solutions and their applications for solving problems in convective, conductive, radiative, and multi-physics problems. Inverse Heat Transfer: Fundamentals and Applications, Second Edition includes

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techniques within the Bayesian framework of statistics for the solution of inverse problems. By modernizing the classic work of the late Professor M. Necati Özisik and adding new examples and problems, this new edition provides a powerful tool for instructors, researchers, and graduate students studying thermal-fluid systems and heat transfer.

FEATURES

- Introduces the fundamental concepts of inverse heat transfer
- Presents in systematic fashion the basic steps of powerful inverse solution techniques
- Develops inverse techniques of parameter estimation, function estimation, and state estimation
- Applies these inverse techniques to the solution of practical inverse heat transfer problems
- Shows inverse techniques for conduction, convection, radiation, and multi-physics phenomena

M. Necati Özisik (1923–2008) retired in 1998 as Professor Emeritus of North Carolina State University's Mechanical and Aerospace Engineering Department. Helcio R. B. Orlande is a Professor of Mechanical Engineering at the Federal University of Rio de Janeiro (UFRJ), where he was the Department Head from 2006 to 2007.

This book is designed for a one-semester graduate course in conduction heat transfer. The three major chapters are: 3 (separation of variables), 8 (finite differences) and 9 (finite elements). Other topics include Bessel functions, Laplace transforms, complex combination, normalization, superposition and Duhamel's theorem.

The following thesis deals with the analytical methods which are in vogue for solving problems to the area of heat conduction. There have been discussed two

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methods, an old method known as the HEAT BALANCE INTEGRAL METHOD, and a relatively newer method christened as the DIFFERENTIAL TRANSFORMATION METHOD. The latter is dealt with first, as it is easier of the two. Dealing involves the basic idea of the method used, followed by the general theorems adopted. Two problems follow, illustrating the ease of use of this method, along with a comparison with the solutions of the problem using the numerical methods. The former method, on the other hand, is more of an assumptive method, where one has to guess a temperature profile for proceeding. This is, nonetheless, a very accurate method, albeit a long one. Similar comparisons have been made for this method, like the ones made for the DT method. The reader may use either method with ease, as it was for the simplification of the problem that these methods were developed.

Heat Transfer is important in food processing. This edited book presents a review of ongoing activities in a broad perspective.

This textbook begins with the finite element method (FEM) before focusing on FEM in heat transfer and fluid mechanics.

Nearly thirty years since its first publication, the highly anticipated fourth edition of Heat Conduction upholds its reputation as an instrumental textbook and reference for graduate students and practicing engineers in mechanical engineering and thermal sciences. Written to suit a one-semester graduate course, the text begins with fundamental concepts,

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introducing the governing equation of heat conduction as derived from the First law of Thermodynamics. Solutions for one-dimensional conduction follow, then orthogonal functions, Fourier series and transforms, and multi-dimensional problems. Later sections focus on a series of specialized techniques, including integral equations, Laplace transforms, finite difference numerical methods, and variational formulations. Two new chapters (9 and 11) have been added to cover heat conduction with local heat sources and heat conduction involving phase change. Applications of Fourier transforms in the semi-infinite and infinite regions have been added to Chapter 7 and Chapter 10 has been expanded to include solutions by the similarity method. Also new to the fourth edition are additional problems at the end of each chapter. This Handbook provides researchers, faculty, design engineers in industrial R&D, and practicing engineers in the field concise treatments of advanced and more-recently established topics in thermal science and engineering, with an important emphasis on micro- and nanosystems, not covered in earlier references on applied thermal science, heat transfer or relevant aspects of mechanical/chemical engineering. Major sections address new developments in heat transfer, transport phenomena, single- and multiphase flows with energy transfer, thermal-bioengineering, thermal

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radiation, combined mode heat transfer, coupled heat and mass transfer, and energy systems. Energy transport at the macro-scale and micro/nano-scales is also included. The internationally recognized team of authors adopt a consistent and systematic approach and writing style, including ample cross reference among topics, offering readers a user-friendly knowledgebase greater than the sum of its parts, perfect for frequent consultation. The Handbook of Thermal Science and Engineering is ideal for academic and professional readers in the traditional and emerging areas of mechanical engineering, chemical engineering, aerospace engineering, bioengineering, electronics fabrication, energy, and manufacturing concerned with the influence thermal phenomena.

A direct solution of the heat conduction equation with prescribed initial and boundary conditions yields temperature distribution inside a specimen. The direct solution is mathematically considered as a well-posed one because the solution exists, is unique, and continuously depends on input data. The estimation of unknown parameters from the measured temperature data is known as the inverse problem of heat conduction. An error in temperature measurement, thermal time lagging, thermocouple-cavity, or signal noise data makes stability a problem in the estimation of unknown parameters. The solution of the inverse problem can be obtained by

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employing the gradient or non-gradient based inverse algorithm. The aim of this book is to analyze the inverse problem and heat exchanger applications in the fields of aerospace, mechanical, applied mechanics, environment sciences, and engineering. Heat Transfer in Structures discusses the heat flow problems directly related to structures. A large section of the book presents the heat conduction in solids. The fundamentals of the analytical method are covered briefly, while introduction on the use of semi-analytical methods is treated in detail. Various approximate methods and finite difference methods are fully explained. The description of structural elements is dealt with extensively. The subject of analogues for finding temperature distributions are briefly discussed, while similarity laws and model testing are covered more comprehensively. Another topic of interest is the heat flow inside the solid part of an ablating body which is covered in detail. Thermal conductance across interfaces and joints are analyzed. And a thorough discussion of the steady heat flow is provided. A section of the text covers the simple structural elements. The book will provide useful information to aeronautics, astronautics, mechanics, engineers, and students of the physical sciences.

Combustion technology has traditionally been dominated by air/fuel combustion. However, two developments have increased the significance of

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oxygen-enhanced combustion—new technologies that produce oxygen less expensively and the increased importance of environmental regulations. Advantages of oxygen-enhanced combustion include less pollutant emissions as well as increased energy efficiency and productivity. *Oxygen-Enhanced Combustion, Second Edition* compiles information about using oxygen to enhance industrial heating and melting processes. It integrates fundamental principles, applications, and equipment design in one volume, making it a unique resource for specialists implementing the use of oxygen in combustion systems. This second edition of the bestselling book has more than doubled in size. Extensively updated and expanded, it covers significant advances in the technology that have occurred since the publication of the first edition. **What's New in This Edition** Expanded from 11 chapters to 30, with most of the existing chapters revised A broader view of oxygen-enhanced combustion, with more than 50 contributors from over 20 organizations around the world More coverage of fundamentals, including fluid flow, heat transfer, noise, flame impingement, CFD modeling, soot formation, burner design, and burner testing New chapters on applications such as flameless combustion, steel reheating, iron production, cement production, power generation, fluidized bed combustion, chemicals and petrochemicals, and diesel engines This book offers

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a unified, up-to-date look at important commercialized uses of oxygen-enhanced combustion in a wide range of industries. It brings together the latest knowledge to assist those researching, engineering, and implementing combustion in power plants, engines, and other applications.

Not only enables readers to include radiation as part of their design and analysis but also appreciate the radiative transfer processes in both nature and engineering systems. Offers two distinguishing features--a whole chapter devoted to the classical dispersion theory which lays a foundation for the discussion of radiative properties presented throughout and a detailed description of particle radiative properties, including real particle size distribution effects. Presents numerous realistic and instructive illustrations and problems involving current topics such as planetary heat transfer, satellite thermal control, atmospheric radiation, radiation in industrial and propulsion combustion systems and more.

Finite Difference Methods in Heat Transfer, Second Edition focuses on finite difference methods and their application to the solution of heat transfer problems. Such methods are based on the discretization of governing equations, initial and boundary conditions, which then replace a continuous partial differential problem by a system of algebraic equations. Finite

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difference methods are a versatile tool for scientists and for engineers. This updated book serves university students taking graduate-level coursework in heat transfer, as well as being an important reference for researchers and engineering. Features Provides a self-contained approach in finite difference methods for students and professionals Covers the use of finite difference methods in convective, conductive, and radiative heat transfer Presents numerical solution techniques to elliptic, parabolic, and hyperbolic problems Includes hybrid analytical–numerical approaches Here is the only commercially published work to deal with the engineering problem of determining surface heat flux and temperature history based on interior temperature measurements. Provides the analytical techniques needed to arrive at otherwise difficult solutions, summarizing the findings of the last ten years. Topics include the steady state solution, Duhamel's Theorem, ill-posed problems, single future time step, and more.

Analytical Heat Diffusion Theory ...

This excellent monograph by two experts presents a generalized and systematic approach to the analytic solution of seven different classes of linear heat and mass diffusion problems. 1984 edition.

This book gives information and guidance on important subjects. It presents the major and efficient applications for efficient insulation materials. The book is divided into two parts. Part I discusses ecological insulation materials. In this part, the three sub-subjects are drafting, Unconventional insulation materials, Jute-Based

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Insulation Material, and Possible Applications of Corn Cob as a Raw Insulation Material. Part II: discusses Practical Applying and Performance of Insulation Materials (case studies), where three sub-subjects are drafting seismic aspects of the application of thermal insulation boards beneath the building's foundations, flammability of bio-based rigid polyurethane foam thermal insulation, and the review of some commonly used methods and techniques to measure the thermal conductivity of insulation materials.

This book introduces the finite element method applied to the resolution of industrial heat transfer problems. Starting from steady conduction, the method is gradually extended to transient regimes, to traditional non-linearities, and to convective phenomena. Coupled problems involving heat transfer are then presented. Three types of couplings are discussed: coupling through boundary conditions (such as radiative heat transfer in cavities), addition of state variables (such as metallurgical phase change), and coupling through partial differential equations (such as electrical phenomena). A review of the various thermal phenomena is drawn up, which an engineer can simulate. The methods presented will enable the reader to achieve optimal use from finite element software and also to develop new applications.

Filling the gap between basic undergraduate courses and advanced graduate courses, this text explains how to analyze and solve conduction, convection, and radiation heat transfer problems analytically. It describes many well-known analytical methods and their solutions,

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such as Bessel functions, separation of variables, similarity method, integral method, and matrix inversion method. Developed from the author's 30 years of teaching, the text also presents step-by-step mathematical formula derivations, analytical solution procedures, and numerous demonstration examples of heat transfer applications.

The long-awaited revision of the bestseller on heat conduction *Heat Conduction, Third Edition* is an update of the classic text on heat conduction, replacing some of the coverage of numerical methods with content on micro- and nanoscale heat transfer. With an emphasis on the mathematics and underlying physics, this new edition has considerable depth and analytical rigor, providing a systematic framework for each solution scheme with attention to boundary conditions and energy conservation. Chapter coverage includes: Heat conduction fundamentals Orthogonal functions, boundary value problems, and the Fourier Series The separation of variables in the rectangular coordinate system The separation of variables in the cylindrical coordinate system The separation of variables in the spherical coordinate system Solution of the heat equation for semi-infinite and infinite domains The use of Duhamel's theorem The use of Green's function for solution of heat conduction The use of the Laplace transform One-dimensional composite medium Moving heat source problems Phase-change problems Approximate analytic methods Integral-transform technique Heat conduction in anisotropic solids Introduction to microscale heat conduction In addition,

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new capstone examples are included in this edition and extensive problems, cases, and examples have been thoroughly updated. A solutions manual is also available. Heat Conduction is appropriate reading for students in mainstream courses of conduction heat transfer, students in mechanical engineering, and engineers in research and design functions throughout industry. Heat transfer is the area of engineering science which describes the energy transport between material bodies due to a difference in temperature. The three different modes of heat transport are conduction, convection and radiation. In most problems, these three modes exist simultaneously. However, the significance of these modes depends on the problems studied and often, insignificant modes are neglected. Very often books published on Computational Fluid Dynamics using the Finite Element Method give very little or no significance to thermal or heat transfer problems. From the research point of view, it is important to explain the handling of various types of heat transfer problems with different types of complex boundary conditions. Problems with slow fluid motion and heat transfer can be difficult problems to handle. Therefore, the complexity of combined fluid flow and heat transfer problems should not be underestimated and should be dealt with carefully. This book: Is ideal for teaching senior undergraduates the fundamentals of how to use the Finite Element Method to solve heat transfer and fluid dynamics problems Explains how to solve various heat transfer problems with different types of boundary conditions Uses recent computational methods and codes to handle complex fluid motion and heat transfer problems Includes a large number of examples and exercises on heat transfer problems In an era of parallel computing, computational efficiency and easy to handle codes play a

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major part. Bearing all these points in mind, the topics covered on combined flow and heat transfer in this book will be an asset for practising engineers and postgraduate students. Other topics of interest for the heat transfer community, such as heat exchangers and radiation heat transfer, are also included.

Heat Transfer in Structures discusses the heat flow problems directly related to structures. A large section of the book presents the heat conduction in solids. The fundamentals of the analytical method are covered briefly, while introduction on the use of semi-analytical methods is treated in detail. Various approximate methods and finite difference methods are fully explained.

Heat transfer analysis is a problem of major significance in a vast range of industrial applications. These extend over the fields of mechanical engineering, aeronautical engineering, chemical engineering and numerous applications in civil and electrical engineering. If one considers the heat conduction equation alone the number of practical problems amenable to solution is extensive. Expansion of the work to include features such as phase change, coupled heat and mass transfer, and thermal stress analysis provides the engineer with the capability to address a further series of key engineering problems. The complexity of practical problems is such that closed form solutions are not generally possible. The use of numerical techniques to solve such problems is therefore considered essential, and this book presents the use of the powerful finite element method in heat transfer analysis. Starting with the fundamental general heat conduction equation, the book moves on to consider the solution of linear steady state heat conduction problems, transient analyses and non-linear examples. Problems of melting and solidification are then considered at length followed by a chapter on convection. The application of heat

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and mass transfer to drying problems and the calculation of both thermal and shrinkage stresses conclude the book. Numerical examples are used to illustrate the basic concepts introduced. This book is the outcome of the teaching and research experience of the authors over a period of more than 20 years.

Nonlinear Heat Transfer: Mathematical Modeling and Analytical Methods addresses recent progress and original research in nonlinear science and its application in the area of heat transfer, with a particular focus on the most important advances and challenging applications. The importance of understanding analytical methods for solving linear and nonlinear constitutive equations is essential in studying engineering problems. This book provides a comprehensive range of (partial) differential equations, applied in the field of heat transfer, tackling a comprehensive range of nonlinear mathematical problems in heat radiation, heat conduction, heat convection, heat diffusion and non-Newtonian fluid systems. Providing various innovative analytical techniques and their practical application in nonlinear engineering problems is the unique point of this book. Drawing a balance between theory and practice, the different chapters of the book focus not only on the broader linear and nonlinear problems, but also applied examples of practical solutions by the outlined methodologies. Demonstrates applied mathematical techniques in the engineering applications, especially in nonlinear phenomena Exhibits a complete understanding of analytical methods and nonlinear differential equations in heat transfer Provides the tools to model and interpret applicable methods in heat transfer processes or systems to solve related complexities

¿ New methods for determining temperature distributions in heterogeneous media, including composite materials ¿ Offers unique tools to predict temperatures in steady-state and

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transient-state conditions; Connects analytical solutions for
temperature distribution with thermal stress analysis

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