

# Advanced Transport Phenomena

This book is a research monograph on transport phenomena. The topics discussed are often mathematically simple, though conceptually complex. The book is written in a colloquial style which a good teacher uses in the classroom. It originates from the author's wealth of teaching experience in this area and incorporates suggestions from colleagues worldwide.

This volume contains the lectures presented at the NATO Advanced Study Institute that took place at the University of Delaware, Newark, Delaware, July 18-27, 1982. The purpose of this Institute was to provide an international forum for exchange of ideas and dissemination of knowledge on some selected topics in Mechanics of Fluids in Porous Media. Processes of transport of such extensive quantities as mass of a phase, mass of a component of a phase, momentum and/or heat occur in diversified fields, such as petroleum reservoir engineering, groundwater hydraulics, soil mechanics, industrial filtration, water purification, wastewater treatment, soil drainage and irrigation, and geothermal energy production. In all these areas, scientists, engineers and planners make use of mathematical models that describe the relevant transport processes that occur within porous medium domains, and enable the forecasting of the future state of the latter in response to planned activities. The mathematical models, in turn, are based on the understanding of phenomena, often within the void space, and on theories that relate these phenomena to measurable quantities. Because of the pressing needs in areas of practical interest, such as the development of groundwater resources, the control and abatement of groundwater contamination, underground energy storage and geothermal energy production, a vast amount of research efforts in all these fields

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has contributed, especially in the last two decades, to our understanding and ability to describe transport phenomena.

Although computer technology has dramatically improved the analysis of complex transport phenomena, the methodology has yet to be effectively integrated into engineering curricula. The huge volume of literature associated with the wide variety of transport processes cannot be appreciated or mastered without using innovative tools to allow comprehension.

An extremely useful guide to the theory and applications of transport phenomena in materials processing. This book defines the unique role that transport phenomena play in materials processing and offers a graphic, comprehensive treatment unlike any other book on the subject. The two parts of the text are, in fact, two useful books. Part I is a very readable introduction to fluid flow, heat transfer, and mass transfer for materials engineers and anyone not yet thoroughly familiar with the subject. It includes governing equations and boundary conditions particularly useful for studying materials processing. For mechanical and chemical engineers, and anyone already familiar with transport phenomena, Part II covers the many specific applications to materials processing, including a brief description of various materials processing technologies. Readable and unencumbered by mathematical manipulations (most of which are allocated to the appendixes), this book is also a useful text for upper-level undergraduate and graduate-level courses in materials, mechanical, and chemical engineering. It includes hundreds of photographs of materials processing in action, single and composite figures of computer simulation, handy charts for problem solving, and more. *Transport Phenomena and Materials Processing*: Describes eight key materials processing technologies, including crystal growth, casting, welding, powder and fiber processing, bulk and

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surface heat treating, and semiconductor device fabrication Covers the latest advances in the field, including recent results of computer simulation and flow visualization Presents special boundary conditions for transport phenomena in materials processing Includes charts that summarize commonly encountered boundary conditions and step-by-step procedures for problem solving Offers a unique derivation of governing equations that leads to both overall and differential balance equations Provides a list of publicly available computer programs and publications relevant to transport phenomena in materials processing

Fluid and flow problems in porous media have attracted the attention of industrialists, engineers and scientists from varying disciplines, such as chemical, environmental, and mechanical engineering, geothermal physics and food science. There has been an increasing interest in heat and fluid flows through porous media, making this book a timely and appropriate resource. Each chapter is systematically detailed to be easily grasped by a research worker with basic knowledge of fluid mechanics, heat transfer and computational and experimental methods. At the same time, the readers will be informed of the most recent research literature in the field, giving it dual usage as both a post-grad text book and professional reference. Written by the recent directors of the NATO Advanced Study Institute session on 'Emerging Technologies and Techniques in Porous Media' (June 2003), this book is a timely and essential reference for scientists and engineers within a variety of fields.

Analysis of Transport Phenomena, Second Edition, provides a unified treatment of momentum, heat, and mass transfer, emphasizing the concepts and analytical techniques that apply to these transport processes. The second edition has been revised to reinforce the progression from simple to complex topics and to better introduce the applied mathematics that is needed

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both to understand classical results and to model novel systems. A common set of formulation, simplification, and solution methods is applied first to heat or mass transfer in stationary media and then to fluid mechanics, convective heat or mass transfer, and systems involving various kinds of coupled fluxes. FEATURES: \* Explains classical methods and results, preparing students for engineering practice and more advanced study or research \* Covers everything from heat and mass transfer in stationary media to fluid mechanics, free convection, and turbulence \* Improved organization, including the establishment of a more integrative approach \* Emphasizes concepts and analytical techniques that apply to all transport processes \* Mathematical techniques are introduced more gradually to provide students with a better foundation for more complicated topics discussed in later chapters Integrating nonequilibrium thermodynamics and kinetic theory, this unique text presents a novel approach to the subject of transport phenomena.

A clear, user-oriented introduction to the subject of computational transport phenomena, first published in 1997.

Advanced Transport Phenomena Fluid Mechanics and Convective Transport Processes  
Cambridge University Press

The subject of transport phenomena has long been thoroughly and expertly addressed on the graduate and theoretical levels. Now Transport Phenomena and Unit Operations: A Combined Approach endeavors not only to introduce the fundamentals of the discipline to a broader, undergraduate-level audience but also to apply itself to the concerns of practicing engineers as they design, analyze, and construct industrial

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equipment. Richard Griskey's innovative text combines the often separated but intimately related disciplines of transport phenomena and unit operations into one cohesive treatment. While the latter was an academic precursor to the former, undergraduate students are often exposed to one at the expense of the other. Transport Phenomena and Unit Operations bridges the gap between theory and practice, with a focus on advancing the concept of the engineer as practitioner. Chapters in this comprehensive volume include: Transport Processes and Coefficients Frictional Flow in Conduits Free and Forced Convective Heat Transfer Heat Exchangers Mass Transfer; Molecular Diffusion Equilibrium Staged Operations Mechanical Separations Each chapter contains a set of comprehensive problem sets with real-world quantitative data, affording students the opportunity to test their knowledge in practical situations. Transport Phenomena and Unit Operations is an ideal text for undergraduate engineering students as well as for engineering professionals. This textbook offers an introduction to multiple, interdependent transport phenomena as they occur in various fields of physics and technology like transport of momentum, heat, and matter. These phenomena are found in a number of combined processes in the fields of chemical, food, biomedical, and environmental sciences. The book puts a special emphasis on numerical modeling of both purely diffusive mechanisms and macroscopic transport such as fluid dynamics, heat and mass convection. To favor the applicability of the various concepts, they are presented with a simplicity of exposure,

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and synthesis has been preferred with respect to completeness. The book includes more than 130 graphs and figures, to facilitate the understanding of the various topics. It also presents many modeling examples throughout the text, to control that the learned material is properly understood. There are some typos in the text. You can see the corrections here: [http://www.springer.com/cda/content/document/cda\\_downloaddocument/ErrataCorrige\\_v0.pdf?SGWID=0-0-45-1679320-p181107156](http://www.springer.com/cda/content/document/cda_downloaddocument/ErrataCorrige_v0.pdf?SGWID=0-0-45-1679320-p181107156)

Rotary Kilns—rotating industrial drying ovens—are used for a wide variety of applications including processing raw minerals and feedstocks as well as heat-treating hazardous wastes. They are particularly critical in the manufacture of Portland cement. Their design and operation is critical to their efficient usage, which if done incorrectly can result in improperly treated materials and excessive, high fuel costs. This professional reference book will be the first comprehensive book in many years that treats all engineering aspects of rotary kilns, including a thorough grounding in the thermal and fluid principles involved in their operation, as well as how to properly design an engineering process that uses rotary kilns. Chapter 1: The Rotary Kiln Evolution & Phenomenon Chapter 2: Basic Description of Rotary Kiln Operation Chapter 3: Freeboard Aerodynamic Phenomena Chapter 4: Granular Flows in Rotary Kilns Chapter 5: Mixing & Segregation Chapter 6: Combustion and Flame Chapter 7: Freeboard Heat Transfer Chapter 8: Heat Transfer Processes in the Rotary Kiln Bed Chapter 9: Mass & Energy Balance Chapter 10: Rotary Kiln Minerals Process

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Applications ·Covers fluid flow, granular flow, mixing and segregation, and aerodynamics during turbulent mixing and recirculation ·Offers hard-to-find guidance on fuels used for rotary kilns, including fuel options such as natural gas versus coal-fired rotary kilns ·Explains principles of combustion and flame control, heat transfer and heating and material balances

Laminar Flow and Convective Transport Processes: Scaling Principles and Asymptotic Analysis presents analytic methods for the solution of fluid mechanics and convective transport processes, all in the laminar flow regime. This book brings together the results of almost 30 years of research on the use of nondimensionalization, scaling principles, and asymptotic analysis into a comprehensive form suitable for presentation in a core graduate-level course on fluid mechanics and the convective transport of heat. A considerable amount of material on viscous-dominated flows is covered. A unique feature of this book is its emphasis on scaling principles and the use of asymptotic methods, both as a means of solution and as a basis for qualitative understanding of the correlations that exist between independent and dependent dimensionless parameters in transport processes. Laminar Flow and Convective Transport Processes is suitable for use as a textbook for graduate courses in fluid mechanics and transport phenomena and also as a reference for researchers in the field.

Introduction to Biotransport Principles is a concise text covering the fundamentals of biotransport, including biological applications of: fluid, heat, and mass transport.

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Never HIGHLIGHT a Book Again Includes all testable terms, concepts, persons, places, and events. Cram101 Just the FACTS101 studyguides gives all of the outlines, highlights, and quizzes for your textbook with optional online comprehensive practice tests. Only Cram101 is Textbook Specific. Accompanies: 9780872893795. This item is printed on demand.

Presenting engineering fundamentals and biological applications in a unified way, this book provides learners with the skills necessary to develop and critically analyze models of biological transport and reaction processes. It covers topics in fluid mechanics, mass transport, and biochemical interactions, with engineering concepts motivated by specific biological problems. For researchers in biomedical engineering. This text provides a teachable and readable approach to transport phenomena (momentum, heat, and mass transport) by providing numerous examples and applications, which are particularly important to metallurgical, ceramic, and materials engineers. Because the authors feel that it is important for students and practicing engineers to visualize the physical situations, they have attempted to lead the reader through the development and solution of the relevant differential equations by applying the familiar principles of conservation to numerous situations and by including many worked examples in each chapter. The book is organized in a manner characteristic of other texts in transport phenomena. Section I deals with the properties and mechanics of fluid motion; Section II with thermal properties and heat transfer; and Section III with diffusion and mass transfer. The authors depart from tradition by building on a presumed understanding of the relationships between the structure and properties of matter, particularly



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in the chapters devoted to the transport properties (viscosity, thermal conductivity, and the diffusion coefficients). In addition, generous portions of the text, numerous examples, and many problems at the ends of the chapters apply transport phenomena to materials processing.

Enables readers to apply transport phenomena principles to solve advanced problems in all areas of engineering and science This book helps readers elevate their understanding of, and their ability to apply, transport phenomena by introducing a broad range of advanced topics as well as analytical and numerical solution techniques. Readers gain the ability to solve complex problems generally not addressed in undergraduate-level courses, including nonlinear, multidimensional transport, and transient molecular and convective transport scenarios. Avoiding rote memorization, the author emphasizes a dual approach to learning in which physical understanding and problem-solving capability are developed simultaneously. Moreover, the author builds both readers' interest and knowledge by: Demonstrating that transport phenomena are pervasive, affecting every aspect of life Offering historical perspectives to enhance readers' understanding of current theory and methods Providing numerous examples drawn from a broad range of fields in the physical and life sciences and engineering Contextualizing problems in scenarios so that their rationale and significance are clear This text generally avoids the use of commercial software for problem solutions, helping readers cultivate a deeper understanding of how solutions are developed. References throughout the text promote further study and encourage the student to contemplate additional topics in transport phenomena. Transport Phenomena is written for advanced undergraduates and graduate students in chemical and mechanical engineering. Upon mastering the principles

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and techniques presented in this text, all readers will be better able to critically evaluate a broad range of physical phenomena, processes, and systems across many disciplines. A new, definitive perspective of electrokinetic and colloid transport processes Responding to renewed interest in the subject of electrokinetics, *Electrokinetic and Colloid Transport Phenomena* is a timely overview of the latest research and applications in this field for both the beginner and the professional. An outgrowth of an earlier text (by coauthor Jacob Masliyah), this self-contained reference provides an up-to-date summary of the literature on electrokinetic and colloid transport phenomena as well as direct pedagogical insight into the development of the subject over the past several decades. A distinct departure from standard colloid science monographs, *Electrokinetic and Colloid Transport Phenomena* presents the most salient features of the theory in a simple and direct manner, allowing the book to serve as a stepping-stone for further learning and study. In addition, the book uniquely discusses numerical simulation of electrokinetic problems and demonstrates the use of commercial finite element software for solving these multiphysics problems. Among the topics covered are: \*

- \* Mathematical preliminaries
- \* Colloidal systems
- \* Electrostatics and application of electrostatics
- \* Electric double layer
- \* Electroosmosis and streaming potential
- \* Electrophoresis and sedimentation potential
- \* London-Van der Waals forces and the DLVO theory
- \* Coagulation and colloid deposition
- \* Numerical simulation of electrokinetic phenomena
- \* Applications of electrokinetic phenomena

Because this thorough reference does not require advanced mathematical knowledge, it enables a graduate or a senior undergraduate student approaching the subject for the first time to easily interpret the theories. On the other hand, the application of relevant mathematical principles and the worked examples are extremely useful to

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established researchers and professionals involved in a wide range of areas, including electroosmosis, streaming potential, electrophoretic separations, industrial practices involving colloids and complex fluids, environmental remediation, suspensions, and microfluidic systems. This book presents balanced treatment of transport phenomena and equal emphasis on mass transport, momentum transport and energy transport. It includes extensive reference to applications of material covered and the addition of appendices on applied mathematics topics, the Boltzmann equation, and a summary of the basic equations in several coordinate systems. 'Transport phenomena' offers literature citations throughout so you and your students know where to find additional material. It contains - Transport properties in two-phase systems; Boundary-layer theory; Heat and mass transfer coefficients; Dimensional analysis and scaling. Plants, in addition to their role as primary synthesizers of organic compounds, have evolved as selective accumulators of inorganic nutrients from the earth's crust. This ability to mine the physical environment is restricted to green plants and some microorganisms, other life forms being directly or indirectly dependent on this process for their supply of mineral nutrients. The initial accumulation of ions by plants is often spatially separated from the photosynthetic parts, necessitating the transport to these parts of the inorganic solutes thus acquired. The requirement for energy-rich materials by the accumulation process is provided by a transport in the opposite direction of organic solutes from the photosynthetic areas. These transport phenomena in plants have been studied at the cellular level, the tissue level, and the whole plant level. The basic problems of analysing the driving forces and the supply of energy for solute transport remain the same for all systems, but the method of approach and the type of results obtained vary widely with the experimental material employed, reflecting the variation of

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the solute transporting properties which have selectively evolved in response to both internal and external environmental pressures.

Modeling in Transport Phenomena, Second Edition presents and clearly explains with example problems the basic concepts and their applications to fluid flow, heat transfer, mass transfer, chemical reaction engineering and thermodynamics. A balanced approach is presented between analysis and synthesis, students will understand how to use the solution in engineering analysis. Systematic derivations of the equations and the physical significance of each term are given in detail, for students to easily understand and follow up the material.

There is a strong incentive in science and engineering to understand why a phenomenon behaves the way it does. For this purpose, a complicated real-life problem is transformed into a mathematically tractable problem while preserving the essential features of it. Such a process, known as mathematical modeling, requires understanding of the basic concepts. This book teaches students these basic concepts and shows the similarities between them. Answers to all problems are provided allowing students to check their solutions. Emphasis is on how to get the model equation representing a physical phenomenon and not on exploiting various numerical techniques to solve mathematical equations. A balanced approach is presented between analysis and synthesis, students will understand how to use the solution in engineering analysis. Systematic derivations of the equations as well as the physical significance of each term are given in detail. Many more problems and examples are given than in the first edition - answers provided

Transport phenomena are the physical forces and processes by which energy and mass are moved into, out of, and throughout a system. Systems that are changing from one state

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(phase) to another, such as liquid to gas, are said to be "multiphase." This advanced text, for the first time, teaches the fundamentals of transport phenomena, including the relevant thermodynamics and kinetics, in the context of multiphase systems. Students will find this an accessible guide to the understanding of an often dauntingly complex subject, with ample worked-out examples taken from real-life engineering problems and helpful end-of-chapter problems to help reinforce abstract concepts. \*Develops and understanding of the thermal and physical behavior of multiphase systems \*Reviews underlying thermodynamics, including thermal equilibria and stability, thermodynamics of surfaces \*Covers all types of phase changes, including melting and solidification, sublimation and vapor deposition, boiling, condensation, and evaporation \*Ample end-of-chapter problems \*Solutions Manual Fully comprehensive introduction to the rapidly emerging area of micro systems technology Transport Phenomena in Micro Systems explores the fundamentals of the new technologies related to Micro-Electro-Mechanical Systems (MEMS). It deals with the behavior, precise control and manipulation of fluids that are geometrically constrained to a small, typically sub-millimeter, scale, such as nl, pl, fl, small size, low energy consumption, effects of the micro domain and heat transfer in the related devices. The author describes in detail and with extensive illustration micro fabrication, channel flow, transport laws, magnetophoresis, micro scale convection and micro sensors and activators, among others. This book spans multidisciplinary fields such as material science and mechanical engineering, engineering, physics, chemistry, microtechnology and biotechnology. Brings together in one collection recent and emerging developments in this fast-growing area of micro systems Covers multidisciplinary fields such as materials science, mechanical engineering, microtechnology

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and biotechnology, et al Comprehensive coverage of analytical models in microfluidics and MEMS technology Introduces micro fluidics applications include the development of inkjet printheads, micro-propulsion, and micro thermal technologies Presented in a very logical format Supplies readers with problems and solutions

This unique resource offers over 200 well-tested bioengineering problems for teaching and examinations. Solutions are available to instructors online.

Introductory Transport Phenomena by R. Byron Bird, Warren E. Stewart, Edwin N. Lightfoot, and Daniel Klingenberg is a new introductory textbook based on the classic Bird, Stewart, Lightfoot text, Transport Phenomena. The authors' goal in writing this book reflects topics covered in an undergraduate course. Some of the rigorous topics suitable for the advanced students have been retained. The text covers topics such as: the transport of momentum; the transport of energy and the transport of chemical species. The organization of the material is similar to Bird/Stewart/Lightfoot, but presentation has been thoughtfully revised specifically for undergraduate students encountering these concepts for the first time.

Devoting more space to mathematical derivations and providing fuller explanations of mathematical developments—including a section of the appendix devoted to mathematical topics—allows students to comprehend transport phenomena concepts at an undergraduate level.

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Integrated, modern approach to transport phenomena for graduate students, featuring examples and computational solutions to develop practical problem-solving skills.

Text on momentum, energy, and mass transfer for graduate engineering students.

Transport phenomena is used here to describe momentum, energy, mass, and entropy transfer (Bird et al. 1960, 1980). It includes thermodynamics, a special case of which is thermostatics. Interfacial transport phenomena refers to momentum, energy, mass, and entropy transfer within the immediate neighborhood of a phase interface, including the thermodynamics of the interface. In terms of qualitative physical observations, this is a very old field. Pliny the Elder (Gaius Plinius Secundus, 23-79 A.D.; Pliny 1938) described divers who released small quantities of oil from their mouths, in order to damp capillary ripples on the ocean surface and in this way provide more uniform lighting for their work. Similar stories were retold by Benjamin Franklin, who conducted experiments of his own in England (Van Doren 1938). In terms of analysis, this is a generally young field. Surface thermostatics developed relatively early, starting with Gibbs (1948) and continuing with important contributions by many others (see Chapter 5).

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Transport phenomena in porous media are encountered in various disciplines, e. g. , civil engineering, chemical engineering, reservoir engineering, agricultural engineering and soil science. In these disciplines, problems are encountered in which various extensive quantities, e. g. , mass and heat, are transported through a porous material domain. Often, the void space of the porous material contains two or three fluid phases, and the various extensive quantities are transported simultaneously through the multiphase system. In all these disciplines, decisions related to a system's development and its operation have to be made. To do so a tool is needed that will provide a forecast of the system's response to the implementation of proposed decisions. This response is expressed in the form of spatial and temporal distributions of the state variables that describe the system's behavior. Examples of such state variables are pressure, stress, strain, density, velocity, solute concentration, temperature, etc. , for each phase in the system. The tool that enables the required predictions is the model. A model may be defined as a simplified version of the real porous medium system and the transport phenomena that occur in it. Because the model is a simplified version of the real system, no unique model exists for a given porous medium system. Different sets of simplifying assumptions, each suitable for a particular task, will result in different models.



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The term transport phenomena is used to describe processes in which mass, momentum, energy and entropy move about in matter. Advances in Transport Phenomena provide state-of-the-art expositions of major advances by theoretical, numerical and experimental studies from a molecular, microscopic, mesoscopic, macroscopic or megascopic point of view across the spectrum of transport phenomena, from scientific enquiries to practical applications. The annual review series intends to fill the information gap between regularly published journals and university-level textbooks by providing in-depth review articles over a broader scope than in journals. The authoritative articles, contributed by international-leading scientists and practitioners, establish the state of the art, disseminate the latest research discoveries, serve as a central source of reference for fundamentals and applications of transport phenomena, and provide potential textbooks to senior undergraduate and graduate students. The series covers mass transfer, fluid mechanics, heat transfer and thermodynamics. The 2009 volume contains the four articles on biomedical, environmental and nanoscale transports. The editorial board expresses its appreciation to the contributing authors and reviewers who have maintained the standard associated with Advances in Transport Phenomena. We also would like to acknowledge the efforts of the staff at Springer who have made the professional and attractive pr-

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entation of the volume. Serial Editorial Board Editor-in-Chief Professor L. Q. Wang The University of Hong Kong, Hong Kong; lqwang@hku. hk Editors Professor A. R. Balakrishnan Indian Institute of Technology Madras, India Professor A.

This book presents the foundations of fluid mechanics and transport phenomena in a concise way. It is suitable as an introduction to the subject as it contains many examples, proposed problems and a chapter for self-evaluation.

This book examines the phenomena of fluid flow and transfer as governed by mechanics and thermodynamics. Part 1 concentrates on equations coming from balance laws and also discusses transportation phenomena and propagation of shock waves. Part 2 explains the basic methods of metrology, signal processing, and system modeling, using a selection of examples of fluid and thermal mechanics.

Part II covers applications in greater detail. The three transport phenomena--heat, mass, and momentum transfer--are treated in depth through simultaneous (or parallel) developments.

Market\_Desc: · Chemical, Mechanical, Nuclear, Industrial Engineers Special

Features: · Careful attention is paid to the presentation of the basic theory·

Enhanced sections throughout text provide much firmer foundation than the first

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edition. Literature citations are given throughout for reference to additional material. About The Book: The long-awaited revision of a classic! This new edition presents a balanced introduction to transport phenomena, which is the foundation of its long-standing success. Topics include mass transport, momentum transport and energy transport, which are presented at three different scales: molecular, microscopic and macroscopic.

Advanced Transport Phenomena is ideal as a graduate textbook. It contains a detailed discussion of modern analytic methods for the solution of fluid mechanics and heat and mass transfer problems, focusing on approximations based on scaling and asymptotic methods, beginning with the derivation of basic equations and boundary conditions and concluding with linear stability theory. Also covered are unidirectional flows, lubrication and thin-film theory, creeping flows, boundary layer theory, and convective heat and mass transport at high and low Reynolds numbers. The emphasis is on basic physics, scaling and nondimensionalization, and approximations that can be used to obtain solutions that are due either to geometric simplifications, or large or small values of dimensionless parameters. The author emphasizes setting up problems and extracting as much information as possible short of obtaining detailed solutions of differential equations. The book also focuses on the solutions of representative

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problems. This reflects the book's goal of teaching readers to think about the solution of transport problems.

One of the questions about which humanity has often wondered is the arrow of time. Why does temporal evolution seem irreversible? That is, we often see objects break into pieces, but we never see them reconstitute spontaneously. This observation was first put into scientific terms by the so-called second law of thermodynamics: entropy never decreases. However, this law does not explain the origin of irreversibility; it only quantifies it. Kinetic theory gives a consistent explanation of irreversibility based on a statistical description of the motion of electrons, atoms, and molecules. The concepts of kinetic theory have been applied to innumerable situations including electronics, the production of particles in the early universe, the dynamics of astrophysical plasmas, quantum gases or the motion of small microorganisms in water, with excellent quantitative agreement. This book presents the fundamentals of kinetic theory, considering classical paradigmatic examples as well as modern applications. It covers the most important systems where kinetic theory is applied, explaining their major features. The text is balanced between exploring the fundamental concepts of kinetic theory (irreversibility, transport processes, separation of time scales, conservations, coarse graining, distribution functions, etc.) and the results and

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predictions of the theory, where the relevant properties of different systems are computed. To request a copy of the Solutions Manual, visit <http://global.oup.com/uk/academic/physics/admin/solutions>.

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Environmental Transport Phenomena offers a detailed yet accessible introduction to transport phenomena. It begins by explaining the underlying principles and mechanisms that govern mass transport and continues by tackling practical problems spanning all subdisciplines of environmental science and chemical engineering. Assuming some knowledge of ordinary differential equations and a familiarity with basic applications of fluid mechanics, this classroom-tested text: Addresses mass conservation and macroscopic mass balances, placing a special emphasis on applications to environmental processes Covers the fundamentals of diffusive transport, applications of the diffusion equation, and diffusive transport in reactive systems Discusses convective transport, hydrodynamic dispersion, and transport in multiphase systems Presents a mathematical framework for formulating and solving transport phenomena problems Environmental Transport Phenomena makes an ideal textbook for a one-semester advanced undergraduate or graduate introductory course in transport phenomena. It provides a fundamental understanding of how to quantify the spread and distribution of contaminants in the environment as well as the

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basis for designing processes related to water purification, wastewater treatment, and solid waste disposal, among others.

The main purpose of this book is to provide the theoretical background to engineers and scientists engaged in modeling transport phenomena in porous media, in connection with various engineering projects, and to serve as a text for senior and graduate courses on transport phenomena in porous media. Such courses are taught in various disciplines, e. g. , civil engineering, chemical engineering, reservoir engineering, agricultural engineering and soil science. In these disciplines, problems are encountered in which various extensive quantities, e. g. , mass and heat, are transported through a porous material domain. Often the porous material contains several fluid phases, and the various extensive quantities are transported simultaneously throughout the multiphase system. In all these disciplines, management decisions related to a system's development and its operation have to be made. To do so, the 'manager', or the planner, needs a tool that will enable him to forecast the response of the system to the implementation of proposed management schemes. This forecast takes the form of spatial and temporal distributions of variables that describe the future state of the considered system. Pressure, stress, strain, density, velocity, solute concentration, temperature, etc. , for each phase in the system, and sometime for

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a component of a phase, may serve as examples of state variables. The tool that enables the required predictions is the model. A model may be defined as a simplified version of the real (porous medium) system that approximately simulates the excitation-response relations of the latter.

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