

Essential Computational Fluid Dynamics Oleg Zikanov Solutions

This Brief will recapitulate the various applications of CFD modeling, discuss the recent developments in this field, and identify the strengths and weaknesses of CFD when applied in the food industry. Computational Fluid Dynamics (CFD) has been applied extensively to great benefit in the food processing sector. Its numerous applications include: predicting the gas flow pattern and particle histories, such as temperature, velocity, residence time, and impact position during spray drying; modeling of ovens to provide information about temperature and airflow pattern throughout the baking chamber to enhance heat transfer and in turn final product quality; designing hybrid heating ovens, such as microwave-infrared, infrared-electrical or microwave-electrical ovens for rapid baking; model the dynamics of gastrointestinal contents during digestion based on the motor response of the GI tract and the physicochemical properties of luminal contents; retort processing of canned solid and liquid foods for understanding and optimization of the heat transfer processes. \u200b 545d0a5092

The twentieth century has witnessed many more examples of applications of fluid dynamics for the use of humanity, all designed without the use of electronic computers. The most straightforward method of attacking any fluid dynamics problem is to solve these equations for the appropriate boundary conditions. The Navier-Stokes equations, which govern the motion of a Newtonian viscous fluid were formulated well over a century ago. Computational Fluid Dynamics (CFD) deals with the numerical analysis of these phenomena. They include prime movers such as internal-combustion engines, gas and steam turbines, flight vehicles, and environmental systems for pollution control and ventilation. Therefore, the \"straightforward\" approach is still impracticable for engineering purposes. Despite impressive progress in recent years, CFD remains an imperfect tool in the comparatively mature discipline of fluid dynamics, partly because electronic digital computers have been in widespread use for less than thirty years. Analytical solutions are few and trivial and, even with today's supercomputers, numerically exact solution of the complete equations for the three-dimensional, time-dependent motion of turbulent flow is prohibitively expensive except for basic research studies in simple configurations at low Reynolds numbers. History reminds us of ancient examples of fluid dynamics applications such as the Roman baths and aqueducts that fulfilled the requirements of the engineers who built them; of ships of various types with adequate hull designs, and of wind energy systems, built long before the subject of fluid mechanics was formalized by Reynolds, Newton, Euler, Navier, Stokes, Prandtl and others 545d0a5092

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. 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. Such a process, known as mathematical modeling, requires understanding of the basic concepts. 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. A balanced approach is presented between analysis and synthesis, students will understand how to use the solution in engineering analysis. Answers to all problems are provided allowing students to check their solutions. This book teaches students these basic concepts and shows the similarities between them. 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. 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 545d0a5092

Computational fluid dynamics (CFD) is concerned with the efficient numerical solution of the partial differential equations that describe fluid dynamics, and CFD techniques are commonly used in many areas of engineering where fluid behavior is a factor. This book covers the range of topics required for a thorough study and understanding of CFD 545d0a5092

Volume 2 will be concerned with the applications of numerical methods to flow problems, and together the two volumes will provide an excellent reference for practitioners and researchers working in computational fluid mechanics and dynamics. Numerical Computation of Internal and External Flows Volume 1: Fundamentals of Numerical Discretization C. In the second part, the various numerical methods are described, while in the third and fourth parts the workings of these methods are investigated in some detail. In this volume, the author explains the use of basic computational methods to solve problems in fluid dynamics, comparing these methods so that the reader can see which would be the most appropriate to use for a particular problem. The book is divided into four parts. Hirsch, Vrije Universiteit Brussel, Brussels, Belgium This is the first of two volumes which together describe comprehensively the theory and practice of the numerical computation of internal and external flows. In the first part, mathematical models are introduced 545d0a5092

A text for a first graduate course in real analysis for students in pure and applied mathematics, statistics, education, engineering, and economics 545d0a5092

"This textbook covers fundamental and advanced concepts of computational fluid dynamics, a powerful and essential tool for fluid flow analysis. The textbook will be accompanied by teaching resources including solution manual for the instructors". It covers fundamental concepts of finite difference and finite volume methods for diffusion, convection-diffusion problems both for cartesian and non-orthogonal grids. The solution of algebraic equations arising due to finite difference and finite volume discretization are highlighted using direct and iterative methods. It discusses various governing equations used in computational fluid dynamics, their derivations, and the physical and mathematical significance of partial differential equations and the boundary conditions. Pedagogical features including solved problems and unsolved exercises are interspersed throughout the text for better understanding. The textbook is primarily written for senior undergraduate and graduate students in the field of mechanical engineering and aerospace engineering, for a course on computational fluid dynamics and heat transfer 545d0a5092

The book emphasizes basic assumptions, physical aspects of the flow, and the appropriate formulations of the governing equations for subsequent analytical treatment. Analytical Fluid Dynamics presents an advanced treatment of inviscid and laminar viscous compressible flows from a theoretical viewpoint. Topics covered include basic concepts, inviscid flow, exact solutions for a viscous flow, and laminar boundary-layer theory for steady two-dimensional or axisymmetric flow. The book complements computational fluid dynamics (CFD) approaches and contains a definitive treatment of the second law of thermodynamics, (unsteady, three-dimensional) shock wave theory, hodograph theory, substitution principle, and first- and second-order boundary-layer theory. It will be a useful text for students and professionals in mechanical engineering, fluid dynamics, physics, aeronautics, and astronautics 545d0a5092

rst presented in 1985 and repeated with modi. The objective, then and now, was to present the subject of computational. uid dynamics, concentrating on their mathematical properties which contain the keys to the choice of the numerical approach. Computational Fluid Dynamics: An Introduction grew out of a von Karman Institute (VKI) Lecture Series by the same title. cations while preserving the introductory nature of the material. Methods of discretizing the equations are discussed and transformation techniques and grids are presented. The book is divided into three parts. A second edition appeared in 1995 with updates to all the chapters and when that printing came to an end, the publisher requested that the editor and authors consider the preparation of a third edition. rst describing the governing equations of. Part II is devoted to four self-contained chapters on more advanced material. cations every year since that time. Two examples of numerical methods close out this part of the book: source and vortex panel methods and the explicit method. Happily, the authors received the request with enthusiasm. uid dynamics (CFD) to an audience unfamiliar with all but the most basic numerical techniques and to do so in such a way that the practical application of CFD would become clear to everyone. The third edition has the goal of presenting additional updates and clari. Roger Grundmann treats the boundary layer equations and methods of solution. John Anderson lays out the subject in Part I by 545d0a5092

In the decades that have passed since this book was published the field of computational fluid dynamics has seen a number of changes in both the sophistication of the algorithms used but also advances in the computer hardware and software available. The computer programs are developed and available in MATLAB. wiley. Y. com/go/biringer. The computer codes at the following website: www. Chow which was originally published in 1979. This new book incorporates the latest algorithms in the solution techniques and supports this by using numerous examples of applications to a broad range of industries from mechanical and aerospace disciplines to civil and the biosciences. This new book builds on the original classic textbook entitled: An Introduction to Computational Fluid Mechanics by C. In addition the core text provides up-to-date solution methods for the Navier-Stokes equations, including fractional step time-advancement, and pseudo-spectral methods 545d0a5092

This well-known 2-volume textbook provides senior undergraduate and postgraduate engineers, scientists and applied mathematicians with the specific techniques, and the framework to develop skills in using the techniques in the various branches of computational fluid dynamics. A solutions manual to the exercises is in preparation 545d0a5092

Leading experts present the current state of knowledge of the subject of magnetoconvection from the viewpoint of applied mathematics 545d0a5092

The chosen semi-discrete approach of a reduction procedure of partial differential equations to ordinary differential equations and finally to difference equations gives the book its distinctiveness and provides a sound basis for a deep understanding of the fundamental concepts in computational fluid dynamics 545d0a5092

We divided this last section into inviscid and viscous flows and attempted to outline the methods for each area and give examples. The first is intended to give the fundamen tals of most types of numerical approaches employed to solve fluid-mechanics problems. In developing this book, we decided to emphasize applications and to provide methods for solving problems. The text contains three sections. The topics of finite differences, finite elements, and spectral meth ods are included, as well as a number of special techniques. The second section is devoted to the solution of incompressible flows by the various numerical approaches. The third section of the book is concerned with compressible flows. We have included solutions of laminar and turbulent-flow prob lems using finite difference, finite element, and spectral methods. As a result, we limited the mathematical devel opments and we tried as far as possible to get insight into the behavior of numerical methods by considering simple mathematical models 545d0a5092

Worked-out solutions are included, with comparisons and discussions. This book introduces a new generation of superfast algorithms for the treatment of the notoriously difficult velocity-pressure coupling problem in incompressible fluid flow solutions. A complete program code is included for faster implementation of the algorithm. A brief literature review of the development of the classical solution procedures is included as well. The derivation and construction of the fully-implicit, block-coupled, incomplete decomposition mechanism are given in a systematic, but easy fashion. It provides all the necessary details for the understanding and implementation of the procedures 545d0a5092

The new edition adds a plethora of new information on such topics as the techniques of interpolation, finite volume discretization on unstructured grids, projection methods, and RANS turbulence modeling. All the attractive features that have contributed to the success of the first edition are retained by this version. It also features a large number of new end-of-chapter problems. The book remains an indispensable guide, which: Introduces CFD to students and working professionals in the areas of practical applications, such as mechanical, civil, chemical, biomedical, or environmental engineering Focuses on the needs of someone who wants to apply existing CFD software and understand how it works, rather than develop new codes Covers all the essential topics, from the basics of discretization to turbulence modeling and uncertainty analysis Discusses complex issues using simple worked examples and reinforces learning with problems Is accompanied by a website hosting lecture presentations and a solution manual Essential Computational Fluid Dynamics, Second Edition is an ideal textbook for senior undergraduate and graduate students taking their first course on CFD. It is also a useful reference for engineers and scientists working with CFD applications. Provides a clear, concise, and self-contained introduction to Computational Fluid Dynamics (CFD) This comprehensively updated new edition covers the fundamental concepts and main methods of modern Computational Fluid Dynamics (CFD). The book has been thoroughly edited to improve clarity and to reflect the recent changes in the practice of CFD. With expert guidance and a wealth of useful techniques, the book offers a clear, concise, and accessible account of the essentials needed to perform and interpret a CFD analysis 545d0a5092

The purpose of this book is to introduce the state-of-the-art concerning this issue and many complementary applications are presented. It allows us to explore reliable non-trivial configurations, differing widely from all known solutions. The numerical optimization of practical applications has been an issue of major importance for the last 10 years 545d0a5092

Several interesting applications area are also discusses in the book like underwater vehicle propeller, the flow behavior in gas-cooled nuclear reactors, simulation odour dispersion around windbreaks and so on. This book provides a comprehensive overview of the computational experiment technology, numerical simulation of the hydrodynamics and heat transfer processes in a two dimensional gas, application of lattice Boltzmann method in heat transfer and fluid flow, etc. Also the aim of the book is the continuous and timely dissemination of new and innovative CFD research and developments. This reference book is a collection of 14 chapters characterized in 4 parts: modern principles of CFD, CFD in physics, industrial and in castle. This book is planned to publish with an objective to provide a state-of-art reference book in the area of computational fluid dynamics for CFD engineers, scientists, applied physicists and post-graduate students 545d0a5092

The book also covers other concepts related to automobiles such as cooling systems and ventilations for vehicles. The book, after giving an introduction to automobile aerodynamics and some fundamentals of fluid mechanics, covers topics such as the performance and aerodynamics of different kinds of vehicles, as well as test techniques for their aerodynamics. The text is recommended for mechanical engineers and phycisists in the automobile industry who would like to understand more about aerodynamics of motor vehicles and its importance on the field of road safety and automobile production. Aerodynamics of Road Vehicles details the aerodynamics of passenger cars, commercial vehicles, sports cars, and race cars; their external flow field; as well as their internal flow field 545d0a5092

Intended as a textbook for courses in computational fluid dynamics at the senior undergraduate or graduate level, this book is a follow-up to the book Fundamentals of Computational Fluid Dynamics by the same authors, which was published in the series Scientific Computation in 2001. These exercises can be included in the context of a typical course and sample solutions are provided in each chapter, so readers can confirm that they have coded the algorithms correctly. A key feature of the book is the inclusion of programming exercises at the end of each chapter based on the numerical solution of the quasi-one-dimensional Euler equations and the shock-tube problem. It focuses on some classical algorithms as well as the underlying ideas based on the latest methods. Whereas the earlier book concentrated on the analysis of numerical methods applied to model equations, this new book concentrates on algorithms for the numerical solution of the Euler and Navier-Stokes equations 545d0a5092

The lecture notes provided in this volume are derived from the special course material. During the special course, a series of comprehensive lectures by leading experts discussed recent advances and technical progress in the area of numerical error estimation and adaptive discretization methods with spe cific emphasis on computational fluid dynamics. Although the task of accurate error estimation for the nonlinear equations of CFD seems a daunting problem, considerable effort has centered on this challenge in recent years with notable progress being made by the use of advanced error estimation techniques and adaptive discretization methods. To address this important topic, a special course was jointly organized by the NATO Research and Technology Office (RTO), the von Karman Insti tute for Fluid Dynamics, and the NASA Ames Research Center. The volume con sists of 6 articles prepared by the special course lecturers. As computational fluid dynamics (CFD) is applied to ever more demanding fluid flow problems, the ability to compute numerical fluid flow solutions to a user specified tolerance as well as the ability to quantify the accuracy of an existing

numerical solution are seen as essential ingredients in robust numerical simulation. The NATO RTO sponsored course entitled "Error Estimation and Solution Adaptive Discretization in CFD" was held September 10-14, 2002 at the NASA Ames Research Center and October 15-19, 2002 at the von Karman Institute in Belgium 545d0a5092

The solution of algebraic equations arising due to finite difference and finite volume discretization are highlighted using direct and iterative methods. It covers fundamental concepts of finite difference and finite volume methods for diffusion, convection-diffusion problems both for cartesian and non-orthogonal grids. It discusses various governing equations used in the field, their derivations, and the physical and mathematical significance of partial differential equations and the boundary conditions. Discusses various higher-order bounded convective schemes, TVD discretisation schemes based on the flux limiter essential for a general purpose CFD computation. A separate chapter on best practice guidelines is included to help CFD practitioners. Covers turbulence modelling like $k-\epsilon$, $k-\omega$, SST $k-\omega$, Reynolds Stress Transport models. Written clearly and with sufficient foundational background to strengthen fundamental knowledge of the topic. Pedagogical features including solved problems and unsolved exercises are interspersed throughout the text for better understanding. Discusses algorithms connected with pressure-linked equations for incompressible flow. Offers a detailed discussion of both finite difference and finite volume methods. This textbook covers fundamental and advanced concepts of computational fluid dynamics, a powerful and essential tool for fluid flow analysis. The textbook will be accompanied by teaching resources including a solution manual for the instructors. The textbook is primarily written for senior undergraduate and graduate students in the field of mechanical engineering and aerospace engineering, for a course on computational fluid dynamics and heat transfer 545d0a5092

This book is an introductory text on magnetohydrodynamics (MHD) - the study of the interaction of magnetic fields and conducting fluids 545d0a5092

The book should be suitable for self-study, as a textbook for CFD short courses, and as a supplement to more comprehensive CFD and fluid dynamics texts. The approach taken is to describe the principal analytical tools required, including truncation-error and stability analyses, followed by the basic elements or building blocks of CFD, which are numerical methods for treating sources, diffusion, convection, and pressure waves. Finally, it is shown how those ingredients may be combined to obtain self-contained numerical methods for solving the full equations of fluid dynamics. This book is a brief introduction to the fundamental concepts of computational fluid dynamics (CFD). It is addressed to beginners, and presents the ABC's or bare essentials of CFD in their simplest and most transparent form 545d0a5092

It emphasizes how the physical concepts (mass conservation or momentum balance) are reflected in the CFD solutions while minimizing the required mathematical/numerical background. In addition, this author: Introduces basic discretizations, the linear advection equation, and forward, backward and central differences Proposes a prototype discretization (first-order upwind) implemented in a spreadsheet/MATLAB example that highlights the diffusive character Looks at consistency, truncation error, and order of accuracy Analyzes the truncation error of the forward, backward, central differences using simple Taylor analysis Demonstrates how the of upwinding produces Artificial Viscosity (AV) and its importance for stability Explains how to select boundary conditions based on physical considerations Illustrates these concepts in a number of carefully discussed case studies Essentials of Computational Fluid Dynamics provides a solid introduction to the basic principles of practical CFD. This book provides a physical description of fluid flow, outlines the strengths and weaknesses of computational fluid dynamics (CFD), presents the basics of the discretization of the equations, focuses on the understanding of how the flow physics interact with a typical finite-volume discretization, and highlights the approximate nature of CFD. Covered from the vantage point of a user of a commercial flow package, Essentials of Computational Fluid Dynamics provides the information needed to competently operate a commercial flow solver. In addition, it uses cases studies in mechanical/aero and biomedical engineering, includes MATLAB and spreadsheet examples, codes and exercise questions. The book also provides practical demonstrations on core principles and key behaviors and incorporates a wide range of colorful examples of CFD simulations in various fields of engineering 545d0a5092

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Students in all engineering disciplines where fluid mechanics is a core course should find this textbook stimulating and useful. In some chapters, the nature of the material necessitates a bias towards practical applications in certain engineering disciplines, and the disciplinary area of the author also contributes to the selection and presentation of practical examples throughout the text. In this latter respect, practical examples related to civil engineering applications are particularly prevalent". The unique features of this textbook are that it: (1) focuses on the basic principles fluid mechanics that engineering students are likely to apply in their subsequent required undergraduate coursework, (2) presents the material in a rigorous fashion, and (3) provides many quantitative examples and illustrations of fluid mechanics applications. "This is a textbook for a first course in fluid mechanics taken by engineering students 545d0a5092

Applied Fluid Mechanics offers a clear and practical presentation of all basic principles of fluid mechanics (both statics and dynamics), tying theory directly to real devices and systems used in mechanical, chemical, civil, and environmental engineering. Full-colour images and colour highlighting make charts, graphs, and tables easier to interpret organise narrative material into more manageable "chunks," and make all of this text's content easier to study. You will continue to access your digital ebook products whilst you have your Bookshelf installed. The full text downloaded to your computer With eBooks you can: search for key concepts, words and phrases make highlights and notes as you study share your notes with friends eBooks are downloaded to your computer and

accessible either offline through the Bookshelf (available as a free download), available online and also via the iPad and Android apps. It presents new procedures for problem-solving and design; more realistic and higher quality illustrations; and more coverage of many topics, including hose, plastic pipe, tubing, pumps, viscosity measurement devices, and computational fluid mechanics. Time limit The eBooks products do not have an expiry date. The 7th edition offers new real-world example problems and integrates the use of world-renowned PIPE-FLO® software for piping system analysis and design. For all fluid mechanics, hydraulics, and related courses in Mechanical, Manufacturing, Chemical, Fluid Power, and Civil Engineering Technology and Engineering programs. Upon purchase, you'll gain instant access to this eBook. The leading applications-oriented approach to engineering fluid mechanics is now in full colour, with integrated software, new problems, and extensive new coverage 545d0a5092

Finally, the author describes a variety of practical applications to problems in turbulence, reacting flows and combustion, acoustics, combined mode radiative heat transfer, multiphase flows, electromagnetic fields, and relativistic astrophysical flows. The next section is devoted to structured and unstructured grids, adaptive methods, computing techniques, and parallel processing. Increasingly, computational fluid dynamics (CFD) techniques are being used to study and solve complex fluid flow and heat transfer problems. Students and practitioners - particularly in mechanical, aerospace, chemical, and civil engineering - will use this authoritative text to learn about and apply numerical techniques to the solution of fluid dynamics problems. Then, FD and FE methods respectively are covered, including both historical developments and recent contributions. It begins with CFD preliminaries, in which the basic principles of finite difference (FD), finite element (FE), and finite volume (FV) methods are discussed and illustrated through examples, with step-by-step hand calculations. This comprehensive book ranges from elementary concepts for the beginner to state-of-the-art CFD for the practitioner 545d0a5092

students of various science and engineering disciplines. It introduces the reader to finite-difference and finite-volume methods for studying and analyzing linear and non-linear problems of fluid flow governed by inviscid incompressible and compressible Euler equations as also incompressible and compressible viscous flows governed by boundary-layer and Navier-Stokes equations. Tech, M. Introduction to Computational Fluid Dynamics is a self-contained introduction to a new subject, arising through the amalgamation of classical fluid dynamics and numerical analysis supported by powerful computers. Tech and M. Simple turbulence modelling has been presented. Written in the style of a text book for advanced level B. Sc 545d0a5092

Common roots and basic principles for many apparently different methods are explained. Moreover, a new section deals with grid quality and an extended description of discretization methods has also been included. The authors describe in detail the most often used techniques. In its third revised and extended edition the book offers an overview of the techniques used to solve problems in fluid mechanics on computers. Included are advanced techniques in computational fluid dynamics, such as direct and large-eddy simulation of turbulence. The book also contains a great deal of practical advice for code developers and users 545d0a5092

Provides a detailed explanation of the process of producing computer solutions to industrial flow problems, illustrating widely-used CFD modelling techniques to the non-specialized user. Detailed case-studies and worked examples are provided 545d0a5092

Applied Fluid Mechanics, Global Edition 545d0a5092

The book has been thoroughly edited to improve clarity and to reflect the recent changes in the practice of CFD. Provides a clear, concise, and self-contained introduction to Computational Fluid Dynamics (CFD) This comprehensively updated new edition covers the fundamental concepts and main methods of modern Computational Fluid Dynamics (CFD). It is also a useful reference for engineers and scientists working with CFD applications. The book remains an indispensable guide, which: Introduces CFD to students and working professionals in the areas of practical applications, such as mechanical, civil, chemical, biomedical, or environmental engineering Focuses on the needs of someone who wants to apply existing CFD software and understand how it works, rather than develop new codes Covers all the essential topics, from the basics of discretization to turbulence modeling and uncertainty analysis Discusses complex issues using simple worked examples and reinforces learning with problems Is accompanied by a website hosting lecture presentations and a solution manual Essential Computational Fluid Dynamics, Second Edition is an ideal textbook for senior undergraduate and graduate students taking their first course on CFD. All the attractive features that have contributed to the success of the first edition are retained by this version. The new edition adds a plethora of new information on such topics as the techniques of interpolation, finite volume discretization on unstructured grids, projection methods, and RANS turbulence modeling. With expert guidance and a wealth of useful techniques, the book offers a clear, concise, and accessible account of the essentials needed to perform and interpret a CFD analysis. It also features a large number of new end-of-chapter problems 545d0a5092

The most teachable book on incompressible flow— now fully revised, updated, and expanded Incompressible Flow, Fourth Edition is the updated and revised edition of Ronald Panton's classic text. Beginning with basic principles, this Fourth Edition patiently develops the math and physics leading to major theories. Throughout, the book provides a unified presentation of physics, mathematics, and engineering applications, liberally supplemented with helpful exercises and example problems. Revised to reflect students' ready access to mathematical computer programs that have advanced

features and are easy to use, Incompressible Flow, Fourth Edition includes: Several more exact solutions of the Navier-Stokes equations Classic-style Fortran programs for the Hiemenz flow, the Psi-Omega method for entrance flow, and the laminar boundary layer program, all revised into MATLAB A new discussion of the global vorticity boundary restriction A revised vorticity dynamics chapter with new examples, including the ring line vortex and the Fraenkel-Norbury vortex solutions A discussion of the different behaviors that occur in subsonic and supersonic steady flows Additional emphasis on composite asymptotic expansions Incompressible Flow, Fourth Edition is the ideal coursebook for classes in fluid dynamics offered in mechanical, aerospace, and chemical engineering programs. It continues a respected tradition of providing the most comprehensive coverage of the subject in an exceptionally clear, unified, and carefully paced introduction to advanced concepts in fluid mechanics 545d0a5092

Professor Jaluria and Torrance have structured a text addressing both finite difference and finite element methods, comparing a number of applicable methods. This new edition updated the material by expanding coverage of certain topics, adding new examples and problems, removing outdated material, and adding a computer disk, which will be included with each book 545d0a5092

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