

## Solution Of Differential Calculus By Das And Mukherjee

This unique book on ordinary differential equations addresses practical issues of composing and solving differential equations by demonstrating the detailed solutions of more than 1,000 examples. The initial draft was used to teach more than 10,000 advanced undergraduate students in engineering, physics, economics, as well as applied mathematics. It is a good source for students to learn problem-solving skills and for educators to find problems for homework assignments and tests. The 2nd edition, with at least 100 more examples and five added subsections, has been restructured to flow more pedagogically.

Mathematics plays an important role in many scientific and engineering disciplines. This book deals with the numerical solution of differential equations, a very important branch of mathematics. Our aim is to give a practical and theoretical account of how to solve a large variety of differential equations, comprising ordinary differential equations, initial value problems and boundary value problems, differential algebraic equations, partial differential equations and delay differential equations. The solution of differential equations using R is the main focus of this book. It is therefore intended for the practitioner, the student and the scientist, who wants to know how to use R for solving differential equations. However, it has been our goal that non-mathematicians should at least understand the basics of the methods, while obtaining entrance into the relevant literature that provides more mathematical background. Therefore, each chapter that deals with R examples is preceded by a chapter where the theory behind the numerical methods being used is introduced. In the sections that deal with the use of R for solving differential equations, we have taken examples from a variety of disciplines, including biology, chemistry, physics, pharmacokinetics. Many examples are well-known test examples, used frequently in the field of numerical analysis.

The material presented in this book corresponds to a semester-long course, "Linear Algebra and Differential Equations", taught to sophomore students at UC Berkeley. In contrast with typical undergraduate texts, the book offers a unifying point of view on the subject, namely that linear algebra solves several clearly-posed classification problems about such geometric objects as quadratic forms and linear transformations. This attractive viewpoint on the classical theory agrees well with modern tendencies in advanced mathematics and is shared by many research mathematicians. However, the idea of classification seldom finds its way to basic programs in mathematics, and is usually unfamiliar to undergraduates. To meet the challenge, the book first guides the reader through the entire agenda of linear algebra in the elementary environment of two-dimensional geometry, and prior to spelling out the general idea and employing it in higher dimensions, shows how it works in applications such as linear ODE systems or stability of equilibria. Appropriate as a text for regular junior and honors sophomore level college classes, the book is accessible to high school students familiar with basic calculus, and can also be useful to engineering graduate students.

Differential Calculus, An Outgrowth Of The Problems Concerned With Slope Of Curved Lines And The Areas Enclosed By Them Has Developed So Much That Texts Are Required Which May Lead The Students Directly To The Heart Of The Subject And Prepare Them For Challenges Of The Field. The Present Book Is An Attempt In This Regard. An Excellent Book On Differential Calculus This Book Has Been Meticulously Planned And Numerous Solved Examples Have Been Selected To Make The Subject Interesting; Besides Problems Are Given At The End Of Each Main Theorem Which Supplement The Text And By Solving Them The Reader Can Judge His Level Of Understanding Of The Given Facts. Exercises Have Been Framed By Arranging Questions In Such A Manner That After Doing Illustrative Examples, One Should Not Feel Difficulty In Solving Any Problem. Considerable Material Has Been Included Here That Covers A Large Number Of Courses. This Has Been Done To Make The Book More Flexible, To Provide A Useful Book Of Reference And To Stimulate Further Interest In The Topics.

The classic introduction to the fundamentals of calculus Richard Courant's classic text Differential and Integral Calculus is an essential text for those preparing for a career in physics or applied math. Volume 1 introduces the foundational concepts of "function" and "limit", and offers detailed explanations that illustrate the "why" as well as the "how". Comprehensive coverage of the basics of integrals and differentials includes their applications as well as clearly-defined techniques and essential theorems. Multiple appendices provide supplementary explanation and author notes, as well as solutions and hints for all in-text problems.

The numerical analysis of stochastic differential equations (SDEs) differs significantly from that of ordinary differential equations. This book provides an easily accessible introduction to SDEs, their applications and the numerical methods to solve such equations. From the reviews: "The authors draw upon their own research and experiences in obviously many disciplines... considerable time has obviously been spent writing this in the simplest language possible." --ZAMP

Excerpt from Elements of the Integral Calculus: With a Key to the Solution of Differential Equations, and a Short Table of Integrals The following volume is a sequel to my treatise on the Differential Calculus, and, like that, is written as a text-hook. The last chapter, however, a Key to the Solution of Differential Equations, may prove of service to working mathematicians. I have used freely the works of Bertrand, Benjamin Peirce, Todhunter, and Boole; and I am much indebted to Professor J. M. Peirce for criticisms and suggestions. About the Publisher Forgotten Books publishes hundreds of thousands of rare and classic books. Find more at [www.forgottenbooks.com](http://www.forgottenbooks.com) This book is a reproduction of an important historical work. Forgotten Books uses state-of-the-art technology to digitally reconstruct the work, preserving the original format whilst repairing imperfections present in the aged copy. In rare cases, an imperfection in the original, such as a blemish or missing page, may be replicated in our edition. We do, however, repair the vast majority of imperfections successfully; any imperfections that remain are intentionally left to preserve the state of such historical works.

The second edition of this groundbreaking book integrates new applications from a variety of fields, especially biology, physics, and engineering. The new handbook is also completely compatible with Mathematica version 3.0 and is a perfect introduction for Mathematica beginners. The CD-ROM contains built-in commands that let the users solve problems directly using graphical solutions.

Solutions to Calculus and Ordinary Differential Equations Firewall Media Calculus Calculus with Analytic Geometry Taylor & Francis Differential and Integral Calculus John Wiley & Sons

Contents: Change of Independent Variables, Maxima and Minima (Of Functions of a Single Independent Variable), Maxima and Minima (Of Functions of Two Independent Variable), Maxima and Minima (Of Function of Several Independent Variable), Envelopes and Evolutes, Jacobians, Singular Points, Curve Tracing.

Enables readers to apply the fundamentals of differential calculus to solve real-life problems in engineering and the physical sciences Introduction to Differential Calculus fully engages readers by presenting the fundamental theories and methods of differential calculus and then showcasing how the discussed concepts can be applied to real-world problems in engineering and the physical sciences. With its easy-to-follow style and accessible explanations, the book sets a solid foundation before advancing to specific calculus methods, demonstrating the connections between differential calculus theory and its applications. The first five chapters introduce underlying concepts such as algebra, geometry, coordinate geometry, and trigonometry. Subsequent chapters present a broad range of theories, methods, and applications in differential calculus, including: Concepts of function, continuity, and derivative Properties of exponential and logarithmic function Inverse trigonometric functions and their properties Derivatives of higher order Methods to find maximum and minimum values of a function Hyperbolic functions and their properties Readers are equipped with the necessary tools to quickly learn how to understand a broad range of current problems throughout the physical sciences and engineering that can only be solved with calculus. Examples throughout provide practical guidance, and practice problems and exercises allow for further development and fine-tuning of various calculus skills. Introduction to Differential Calculus is an excellent book for upper-undergraduate calculus courses and is also an ideal reference for students and professionals alike who would like to gain a further understanding of the use of calculus to solve problems in a simplified manner.

An accessible introduction to the fundamentals of calculus needed to solve current problems in engineering and the physical sciences Integration is an important function of calculus, and Introduction to Integral Calculus combines fundamental concepts with scientific problems to develop intuition and skills for solving mathematical problems related to engineering and the physical sciences. The authors provide a solid introduction to integral calculus and feature applications of integration, solutions of differential equations, and evaluation methods. With logical organization coupled with clear, simple explanations, the authors reinforce new concepts to progressively build skills and knowledge, and numerous real-world examples as well as intriguing applications help readers to better understand the connections between the theory of calculus and practical problem solving. The first six chapters address the prerequisites needed to understand the principles of integral calculus and explore such topics as anti-derivatives, methods of converting integrals into standard form, and the concept of area. Next, the authors review numerous methods and applications of integral calculus, including: Mastering and applying the first and second fundamental theorems of calculus to compute definite integrals Defining the natural logarithmic function using calculus Evaluating definite integrals Calculating plane areas bounded by curves Applying basic concepts of differential equations to solve ordinary differential equations With this book as their guide, readers quickly learn to solve a broad range of current problems throughout the physical sciences and engineering that can only be solved with calculus. Examples throughout provide practical guidance, and practice problems and exercises allow for further development and fine-tuning of various calculus skills. Introduction to Integral Calculus is an excellent book for upper-undergraduate calculus courses and is also an ideal reference for students and professionals who would like to gain a further understanding of the use of calculus to solve problems in a simplified manner.

Ideal for self-instruction as well as for classroom use, this text improves understanding and problem-solving skills in analysis, analytic geometry, and higher algebra. Over 1,200 problems, with hints and complete solutions. 1963 edition.

The fun and easy way to understand and solve complex equations Many of the fundamental laws of physics, chemistry, biology, and economics can be formulated as differential equations. This plain-English guide explores the many applications of this mathematical tool and shows how differential equations can help us understand the world around us. Differential Equations For Dummies is the perfect companion for a college differential equations course and is an ideal supplemental resource for other calculus classes as well as science and engineering courses. It offers step-by-step techniques, practical tips, numerous exercises, and clear, concise examples to help readers improve their differential equation-solving skills and boost their test scores.

This introductory text explores 1st- and 2nd-order differential equations, series solutions, the Laplace transform, difference equations, much more. Numerous figures, problems with solutions, notes. 1994 edition. Includes 268 figures and 23 tables.

This book reviews the algebraic prerequisites of calculus, including solving equations, lines, quadratics, functions, logarithms, and trig functions. It introduces the derivative using the limit-based definition and covers the standard function library and the product, quotient, and chain rules. It explores the applications of the derivative to curve sketching and optimization and concludes with the formal definition of the limit, the squeeze theorem, and the mean value theorem.

This problem book contains exercises for courses in differential equations and calculus of variations at universities and technical institutes. It is designed for non-mathematics students and also for scientists and practicing engineers who feel a need to refresh their knowledge. The book contains more than 260 examples and about 1400 problems to be solved by the students — much of which have been composed by the authors themselves. Numerous references are given at the end of the book to furnish sources for detailed theoretical approaches, and expanded treatment of applications. Contents: First Order Differential Equations N-th Order Differential Equations Linear Second Order Equations Systems of Differential Equations Partial Equations of the First Order Nonlinear Equations and Stability Calculus of Variations Answers to Problems Readership: Mathematicians and engineers. keywords: Examples; Differential Equations; Calculus of Variations "... the book can be successfully used both by students and practising engineers." Mathematics Abstracts

Now enhanced with the innovative DE Tools CD-ROM and the iLrn teaching and learning system, this proven text explains the "how" behind the material and strikes a balance between the analytical, qualitative, and quantitative approaches to the study of differential equations. This accessible text speaks to students through a wealth of pedagogical aids, including an abundance of examples, explanations, "Remarks" boxes, definitions, and group projects. This book was written with the student's understanding firmly in mind. Using a straightforward, readable, and helpful style, this book provides a thorough treatment of boundary-value problems and partial differential equations.

Excerpt from Elements of the Integral Calculus: With a Key to the Solution of Differential Equations The following volume is a sequel to my treatise on the Differential Calculus, and, like that, is written as a text-book. The last chapter, however, a Key to the Solution of Differential Equations, may prove of service to working mathematicians. I have used freely the works of Bertrand, Benjamin Peirce, Todhunter, and Boole; and I am much indebted to Professor J. M. Peirce for criticisms and suggestions. About the Publisher Forgotten Books publishes hundreds of thousands of rare and classic books. Find more at [www.forgottenbooks.com](http://www.forgottenbooks.com) This book is a reproduction of an important historical work. Forgotten Books uses state-of-the-art technology to digitally reconstruct the work, preserving the original format whilst repairing imperfections present in the aged copy. In rare cases, an imperfection in the original, such as a blemish or missing page, may be replicated in our edition. We do, however, repair the vast majority of imperfections successfully; any imperfections that remain are intentionally left to preserve the state of such historical works.

In this book, how to solve such type equations has been elaborately described. In this book, vector differential calculus is considered, which extends the basic concepts of (ordinary) differential calculus, such as, continuity and differentiability to vector functions in a simple and natural way. This book comprises previous question papers problems at appropriate places and also previous GATE questions at the end of each chapter for the

"Published by OpenStax College, Calculus is designed for the typical two- or three-semester general calculus course, incorporating innovative features to enhance student learning. The book guides students through the core concepts of calculus and helps them understand how those concepts apply to their lives and the world around them. Due to the comprehensive nature of the material, we are offering the book in three volumes for flexibility and efficiency. Volume 1 covers functions, limits, derivatives, and integration."--BC Campus website.

Skillfully organized introductory text examines origin of differential equations, then defines basic terms and outlines the general solution of a differential equation. Subsequent sections deal with integrating factors; dilution and accretion problems; linearization of first order systems; Laplace Transforms; Newton's Interpolation Formulas, more.

Mathematica is a platform for scientific computing that helps you to work in virtually all areas of the experimental sciences and engineering. In particular, this software presents quite extensive capabilities and implements a large number of commands enabling you to efficiently handle problems involving Differential Calculus. Using Mathematica you will be able to work with Limits, Numerical and power series, Taylor and MacLaurin series, continuity, derivability, differentiability in several variables, optimization and differential equations. Mathematica also implements numerical methods for the approximate solution of differential equations. The main content of the book is as follows: LIMITS AND CONTINUITY. ONE AND SEVERAL VARIABLES 1.1 LIMITS OF SEQUENCES 1.2 LIMITS OF FUNCTIONS. LATERAL LIMITS 1.3 CONTINUITY 1.4 SEVERAL VARIABLES: LIMITS AND CONTINUITY. CHARACTERIZATION THEOREMS 1.5 ITERATED AND DIRECTIONAL LIMITS 1.6 CONTINUITY IN SEVERAL VARIABLES NUMERICAL SERIES AND POWER SERIES 2.1 SERIES. CONVERGENCE CRITERIA 2.2 NUMERICAL SERIES WITH NON-NEGATIVE TERMS 2.3 ALTERNATING NUMERICAL SERIES 2.4 POWER SERIES 2.5 POWER SERIES EXPANSIONS AND FUNCTIONS 2.6 TAYLOR AND LAURENT EXPANSIONS DERIVATIVES AND APPLICATIONS. ONE AND SEVERAL VARIABLES 3.1 THE CONCEPT OF THE DERIVATIVE 3.2 CALCULATING DERIVATIVES 3.3 TANGENTS, ASYMPTOTES, CONCAVITY, CONVEXITY, MAXIMA AND MINIMA, INFLECTION POINTS AND GROWTH 3.4 APPLICATIONS TO PRACTICAL PROBLEMS 3.5 PARTIAL DERIVATIVES 3.6 IMPLICIT DIFFERENTIATION DERIVABILITY IN SEVERAL VARIABLES 4.1 DIFFERENTIATION OF FUNCTIONS OF SEVERAL VARIABLES 4.2 MAXIMA AND MINIMA OF FUNCTIONS OF SEVERAL VARIABLES 4.3 CONDITIONAL MINIMA AND MAXIMA. THE METHOD OF "LAGRANGE MULTIPLIERS" 4.4 SOME APPLICATIONS OF MAXIMA AND MINIMA IN SEVERAL VARIABLES VECTOR DIFFERENTIAL CALCULUS AND THEOREMS IN SEVERAL VARIABLES 5.1 CONCEPTS OF VECTOR DIFFERENTIAL CALCULUS 5.2 THE CHAIN RULE 5.3 THE IMPLICIT FUNCTION THEOREM 5.4 THE INVERSE FUNCTION THEOREM 5.5 THE CHANGE OF VARIABLES THEOREM 5.6 TAYLOR'S THEOREM WITH N VARIABLES 5.7 VECTOR FIELDS. CURL, DIVERGENCE AND THE LAPLACIAN 5.8 COORDINATE TRANSFORMATION DIFFERENTIAL EQUATIONS 6.1 SEPARATION OF VARIABLES 6.2 HOMOGENEOUS DIFFERENTIAL EQUATIONS 6.3 EXACT DIFFERENTIAL EQUATIONS 6.4 LINEAR DIFFERENTIAL EQUATIONS 6.5 NUMERICAL SOLUTIONS TO DIFFERENTIAL EQUATIONS OF THE FIRST ORDER 6.6 ORDINARY HIGH-ORDER EQUATIONS 6.7 HIGHER-ORDER LINEAR HOMOGENEOUS EQUATIONS WITH CONSTANT COEFFICIENTS 6.8 NON-HOMOGENEOUS EQUATIONS WITH CONSTANT COEFFICIENTS. VARIATION OF PARAMETERS 6.9 NON-HOMOGENEOUS LINEAR EQUATIONS WITH VARIABLE COEFFICIENTS. CAUCHY-EULER EQUATIONS 6.10 THE LAPLACE TRANSFORM 6.11 SYSTEMS OF LINEAR HOMOGENEOUS EQUATIONS WITH CONSTANT COEFFICIENTS 6.12 SYSTEMS OF LINEAR NON-HOMOGENEOUS EQUATIONS WITH CONSTANT COEFFICIENTS 6.13 HIGHER ORDER EQUATIONS AND APPROXIMATION METHODS 6.14 THE EULER METHOD 6.15 THE RUNGE-KUTTA METHOD 6.16 DIFFERENTIAL EQUATIONS SYSTEMS BY APPROXIMATE METHODS 6.17 DIFFERENTIAL EQUATIONS IN PARTIAL DERIVATIVES 6.18 ORTHOGONAL POLYNOMIALS

This book on Differential Calculus has been written for the use of the students of degree and honours classes of Indian Universities. The subject matter has been discussed in such a simple way that the students will find no difficulty to understand it. The theories and articles have been explained in detailed in a nice manner and all the examples have been completely solved. Self practice problems in such chapter will help students self evaluation. Hints and answers to self practice problems enable to students learn at their own pace. The book contains almost all the questions set at various examinations held by Indian Universities and it covers to syllabi of all Indian Universities. Contents: Function of Real Variable, Limits, Continuity and Differentiability, Rolle s Theorem, Mean Value Theorems, Taylor s and Maclaurin s Theorems, Differentiation, Successive Differentiation, Expansions of Functions, Partial Differential, Indeterminate Forms, Tangents and Norms, Curvature, Asymptotes.

This textbook is aimed at newcomers to nonlinear dynamics and chaos, especially students taking a first course in the subject. The presentation stresses analytical methods, concrete examples, and geometric intuition. The theory is developed systematically, starting with first-order differential equations and their bifurcations, followed by phase plane analysis, limit cycles

and their bifurcations, and culminating with the Lorenz equations, chaos, iterated maps, period doubling, renormalization, fractals, and strange attractors.

Multivariable Calculus, Linear Algebra, and Differential Equations, Second Edition contains a comprehensive coverage of the study of advanced calculus, linear algebra, and differential equations for sophomore college students. The text includes a large number of examples, exercises, cases, and applications for students to learn calculus well. Also included is the history and development of calculus. The book is divided into five parts. The first part includes multivariable calculus material. The second part is an introduction to linear algebra. The third part of the book combines techniques from calculus and linear algebra and contains discussions of some of the most elegant results in calculus including Taylor's theorem in "n" variables, the multivariable mean value theorem, and the implicit function theorem. The fourth section contains detailed discussions of first-order and linear second-order equations. Also included are optional discussions of electric circuits and vibratory motion. The final section discusses Taylor's theorem, sequences, and series. The book is intended for sophomore college students of advanced calculus.

This package (book + CD-ROM) has been replaced by the ISBN 0321388410 (which consists of the book alone). The material that was on the CD-ROM is available for download at <http://aw-bc.com/nss> Fundamentals of Differential Equations presents the basic theory of differential equations and offers a variety of modern applications in science and engineering. Available in two versions, these flexible texts offer the instructor many choices in syllabus design, course emphasis (theory, methodology, applications, and numerical methods), and in using commercially available computer software. Fundamentals of Differential Equations, Seventh Edition is suitable for a one-semester sophomore- or junior-level course. Fundamentals of Differential Equations with Boundary Value Problems, Fifth Edition, contains enough material for a two-semester course that covers and builds on boundary value problems. The Boundary Value Problems version consists of the main text plus three additional chapters (Eigenvalue Problems and Sturm-Liouville Equations; Stability of Autonomous Systems; and Existence and Uniqueness Theory). This textbook commences with a brief outline of development of real numbers, their expression as infinite decimals and their representation by points along a line. While the first part of the textbook is analytical, the latter part deals with the geometrical applications of the subject. Numerous examples and exercises have been provided to support student's understanding. This textbook has been designed to meet the requirements of undergraduate students of BA and BSc courses.

An authorised reissue of the long out of print classic textbook, Advanced Calculus by the late Dr Lynn Loomis and Dr Shlomo Sternberg both of Harvard University has been a revered but hard to find textbook for the advanced calculus course for decades. This book is based on an honors course in advanced calculus that the authors gave in the 1960's. The foundational material, presented in the unstarred sections of Chapters 1 through 11, was normally covered, but different applications of this basic material were stressed from year to year, and the book therefore contains more material than was covered in any one year. It can accordingly be used (with omissions) as a text for a year's course in advanced calculus, or as a text for a three-semester introduction to analysis. The prerequisites are a good grounding in the calculus of one variable from a mathematically rigorous point of view, together with some acquaintance with linear algebra. The reader should be familiar with limit and continuity type arguments and have a certain amount of mathematical sophistication. As possible introductory texts, we mention Differential and Integral Calculus by R Courant, Calculus by T Apostol, Calculus by M Spivak, and Pure Mathematics by G Hardy. The reader should also have some experience with partial derivatives. In overall plan the book divides roughly into a first half which develops the calculus (principally the differential calculus) in the setting of normed vector spaces, and a second half which deals with the calculus of differentiable manifolds.

While the standard sophomore course on elementary differential equations is typically one semester in length, most of the texts currently being used for these courses have evolved into calculus-like presentations that include a large collection of methods and applications, packaged with state-of-the-art color graphics, student solution manuals, the latest fonts, marginal notes, and web-based supplements. All of this adds up to several hundred pages of text and can be very expensive. Many students do not have the time or desire to read voluminous texts and explore internet supplements. That's what makes the format of this differential equations book unique. It is a one-semester, brief treatment of the basic ideas, models, and solution methods. Its limited coverage places it somewhere between an outline and a detailed textbook. The author writes concisely, to the point, and in plain language. Many worked examples and exercises are included. A student who works through this primer will have the tools to go to the next level in applying ODEs to problems in engineering, science, and applied mathematics. It will also give instructors, who want more concise coverage, an alternative to existing texts. This text also encourages students to use a computer algebra system to solve problems numerically. It can be stated with certainty that the numerical solution of differential equations is a central activity in science and engineering, and it is absolutely necessary to teach students scientific computation as early as possible. Templates of MATLAB programs that solve differential equations are given in an appendix. Maple and Mathematica commands are given as well. The author taught this material on several occasions to students who have had a standard three-semester calculus sequence. It has been well received by many students who appreciated having a small, definitive parcel of material to learn. Moreover, this text gives students the opportunity to start reading mathematics at a slightly higher level than experienced in pre-calculus and calculus; not every small detail is included. Therefore the book can be a bridge in their progress to study more advanced material at the junior-senior level, where books leave a lot to the reader and are not packaged with elementary formats. J. David Logan is Professor of Mathematics at the University of Nebraska, Lincoln. He is the author of another recent undergraduate textbook, Applied Partial Differential Equations, 2nd Edition (Springer 2004).

This book provides an extensive collection of problems with detailed solutions in introductory and advanced matrix calculus. Supplementary problems in each chapter will challenge and excite the reader, ideal for both graduate and undergraduate mathematics and theoretical physics students. The coverage includes systems of linear equations, linear differential equations, integration and matrices, Kronecker product and vec-operation as well as functions of matrices. Furthermore, specialized topics such as spectral

theorem, nonnormal matrices and mutually unbiased bases are included. Many of the problems are related to applications for group theory, Lie algebra theory, wavelets, graph theory and matrix-valued differential forms, benefitting physics and engineering students and researchers alike. It also branches out to problems with tensors and the hyperdeterminant. Computer algebra programs in Maxima and SymbolicC++ have also been provided.

Differential Equations presents the basics of differential equations. With equal emphasis on theoretical and practical concepts, the book provides a balanced coverage of all topics essential to master the subject at the undergraduate level.

Active Calculus is different from most existing texts in that: the text is free to read online in .html or via download by users in .pdf format; in the electronic format, graphics are in full color and there are live .html links to java applets; the text is open source, so interested instructor can gain access to the original source files via GitHub; the style of the text requires students to be active learners ... there are very few worked examples in the text, with there instead being 3-4 activities per section that engage students in connecting ideas, solving problems, and developing understanding of key calculus ideas; each section begins with motivating questions, a brief introduction, and a preview activity; each section concludes (in .html) with live WeBWork exercises for immediate feedback, followed by a few challenging problems.

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