

## Modern Computer Algebra

Formal development of the mathematical theory of quantum information with clear proofs and exercises. For graduate students and researchers.

The book provides an introduction to modern abstract algebra and its applications. It covers all major topics of classical theory of numbers, groups, rings, fields and finite dimensional algebras. The book also provides interesting and important modern applications in such subjects as Cryptography, Coding Theory, Computer Science and Physics. In particular, it considers algorithm RSA, secret sharing algorithms, Diffie-Hellman Scheme and ElGamal cryptosystem based on discrete logarithm problem. It also presents Buchberger's algorithm which is one of the important algorithms for constructing Gröbner basis. Key Features: Covers all major topics of classical theory of modern abstract algebra such as groups, rings and fields and their applications. In addition it provides the introduction to the number theory, theory of finite fields, finite dimensional algebras and their applications. Provides interesting and important modern applications in such subjects as Cryptography, Coding Theory, Computer Science and Physics. Presents numerous examples illustrating the theory and applications. It is also filled with a number of exercises of various difficulty. Describes in detail the construction of the Cayley-Dickson construction for finite dimensional algebras, in particular, algebras of quaternions and octonions and gives their applications in the number theory

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and computer graphics.

This book provides a systematic approach for the algorithmic formulation and implementation of mathematical operations in computer algebra programming languages. The viewpoint is that mathematical expressions, represented by expression trees, are the data objects of computer algebra programs, and by using a few primitive operations that analyze and

Successful advanced textbook and reference on computer algebra for computer scientists and mathematicians.

Written at a level appropriate to undergraduates, this book covers such topics as the Hilbert Basis Theorem, the Nullstellensatz, invariant theory, projective geometry, and dimension theory. Contains a new section on Axiom and an update about MAPLE, Mathematica and REDUCE.

This textbook, for second- or third-year students of computer science, presents insights, notations, and analogies to help them describe and think about algorithms like an expert, without grinding through lots of formal proof. Solutions to many problems are provided to let students check their progress, while class-tested PowerPoint slides are on the web for anyone running the course. By looking at both the big picture and easy step-by-step methods for developing algorithms, the author guides students around the common pitfalls. He stresses paradigms such as loop invariants and recursion to unify a huge range of algorithms into a few meta-algorithms. The book fosters a deeper

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understanding of how and why each algorithm works. These insights are presented in a careful and clear way, helping students to think abstractly and preparing them for creating their own innovative ways to solve problems.

Now in its third edition, this highly successful textbook is widely regarded as the 'bible of computer algebra'.

Introduces exciting new methods for assessing algorithms for problems ranging from clustering to linear programming to neural networks.

Discrete optimization problems are everywhere, from traditional operations research planning (scheduling, facility location and network design); to computer science databases; to advertising issues in viral marketing. Yet most such problems are NP-hard; unless  $P = NP$ , there are no efficient algorithms to find optimal solutions. This book shows how to design approximation algorithms: efficient algorithms that find provably near-optimal solutions. The book is organized around central algorithmic techniques for designing approximation algorithms, including greedy and local search algorithms, dynamic programming, linear and semidefinite programming, and randomization. Each chapter in the first section is devoted to a single algorithmic technique applied to several different problems, with more sophisticated treatment in the second section. The book also covers methods for proving that optimization problems are hard to approximate. Designed as a textbook for graduate-level algorithm courses, it will also serve as a reference for researchers interested in the heuristic solution of discrete optimization problems.

This book can be understood as a model for teaching commutative algebra, and takes into

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account modern developments such as algorithmic and computational aspects. As soon as a new concept is introduced, the authors show how the concept can be worked on using a computer. The computations are exemplified with the computer algebra system Singular, developed by the authors. Singular is a special system for polynomial computation with many features for global as well as for local commutative algebra and algebraic geometry. The book includes a CD containing Singular as well as the examples and procedures explained in the book.

Standard text provides an exceptionally comprehensive treatment of every aspect of modern algebra. Explores algebraic structures, rings and fields, vector spaces, polynomials, linear operators, much more. Over 1,300 exercises. 1965 edition.

This book offers an introduction to cryptology, the science that makes secure communications possible, and addresses its two complementary aspects: cryptography—the art of making secure building blocks—and cryptanalysis—the art of breaking them. The text describes some of the most important systems in detail, including AES, RSA, group-based and lattice-based cryptography, signatures, hash functions, random generation, and more, providing detailed underpinnings for most of them. With regard to cryptanalysis, it presents a number of basic tools such as the differential and linear methods and lattice attacks. This text, based on lecture notes from the author's many courses on the art of cryptography, consists of two interlinked parts. The first, modern part explains some of the basic systems used today and some attacks on them. However, a text on cryptology would not be complete without describing its rich and fascinating history. As such, the colorfully illustrated historical part interspersed throughout the text highlights selected inventions and episodes, providing a glimpse into the past of

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cryptology. The first sections of this book can be used as a textbook for an introductory course to computer science or mathematics students. Other sections are suitable for advanced undergraduate or graduate courses. Many exercises are included. The emphasis is on providing reasonably complete explanation of the background for some selected systems. The goal of *Computer Algebra: Concepts and Techniques* is to demystify computer algebra systems for a wide audience including students, faculty, and professionals in scientific fields such as computer science, mathematics, engineering, and physics. Unlike previous books, the only prerequisites are knowledge of first year calculus and a little programming experience — a background that can be assumed of the intended audience. The book is written in a lean and lively style, with numerous examples to illustrate the issues and techniques discussed. It presents the principal algorithms and data structures, while also discussing the inherent and practical limitations of these systems

This book presents methods for the computational solution of some important problems of linear algebra: linear systems, linear least squares problems, eigenvalue problems, and linear programming problems. The book also includes a chapter on the fast Fourier transform and a very practical introduction to the solution of linear algebra problems on modern supercomputers. The book contains the relevant theory for most of the methods employed. It also emphasizes the practical aspects involved in implementing the methods. Students using this book will actually see and write programs for solving linear algebraic problems. Highly readable FORTRAN and MATLAB codes are presented which solve all of the main problems studied.

Advanced algebra in the service of contemporary mathematical research-- a unique

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introduction. This volume takes an altogether new approach to advanced algebra. Its intriguing title, inspired by the term postmodernism, denotes a departure from van der Waerden's *Modern Algebra*--a book that has dominated the field for nearly seventy years. *Post-Modern Algebra* offers a truly up-to-date alternative to the standard approach, explaining topics from an applications-based perspective rather than by abstract principles alone. The book broadens the field of study to include algebraic structures and methods used in current and emerging mathematical research, and describes the powerful yet subtle techniques of universal algebra and category theory. Classical algebraic areas of groups, rings, fields, and vector spaces are bolstered by such topics as ordered sets, monoids, monoid actions, quasigroups, loops, lattices, Boolean algebras, categories, and Heyting algebras. The text features:

- \* A clear and concise treatment at an introductory level, tested in university courses.
- \* A wealth of exercises illustrating concepts and their practical application.
- \* Effective techniques for solving research problems in the real world.
- \* Flexibility of presentation, making it easy to tailor material to specific needs.
- \* Help with elementary proofs and algebraic notations for students of varying abilities.

*Post-Modern Algebra* is an excellent primary or supplementary text for graduate-level algebra courses. It is also an extremely useful resource for professionals and researchers in many areas who must tackle abstract, linear, or universal algebra in the course of their work. Planning algorithms are impacting technical disciplines and industries around the world, including robotics, computer-aided design, manufacturing, computer graphics, aerospace applications, drug design, and protein folding. This coherent and comprehensive book unifies material from several sources, including robotics, control theory, artificial intelligence, and algorithms. The treatment is centered on robot motion planning, but integrates material on

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planning in discrete spaces. A major part of the book is devoted to planning under uncertainty, including decision theory, Markov decision processes, and information spaces, which are the 'configuration spaces' of all sensor-based planning problems. The last part of the book delves into planning under differential constraints that arise when automating the motions of virtually any mechanical system. This text and reference is intended for students, engineers, and researchers in robotics, artificial intelligence, and control theory as well as computer graphics, algorithms, and computational biology.

This introductory book emphasises algorithms and applications, such as cryptography and error correcting codes.

Algorithms for Computer Algebra is the first comprehensive textbook to be published on the topic of computational symbolic mathematics. The book first develops the foundational material from modern algebra that is required for subsequent topics. It then presents a thorough development of modern computational algorithms for such problems as multivariate polynomial arithmetic and greatest common divisor calculations, factorization of multivariate polynomials, symbolic solution of linear and polynomial systems of equations, and analytic integration of elementary functions. Numerous examples are integrated into the text as an aid to understanding the mathematical development. The algorithms developed for each topic are presented in a Pascal-like computer language. An extensive set of exercises is presented at the end of each chapter. Algorithms for Computer Algebra is suitable for use as a textbook for a course on algebraic algorithms at the third-year, fourth-year, or graduate level. Although

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the mathematical development uses concepts from modern algebra, the book is self-contained in the sense that a one-term undergraduate course introducing students to rings and fields is the only prerequisite assumed. The book also serves well as a supplementary textbook for a traditional modern algebra course, by presenting concrete applications to motivate the understanding of the theory of rings and fields.

Algorithmic Algebra studies some of the main algorithmic tools of computer algebra, covering such topics as Gröbner bases, characteristic sets, resultants and semialgebraic sets. The main purpose of the book is to acquaint advanced undergraduate and graduate students in computer science, engineering and mathematics with the algorithmic ideas in computer algebra so that they could do research in computational algebra or understand the algorithms underlying many popular symbolic computational systems: Mathematica, Maple or Axiom, for instance. Also, researchers in robotics, solid modeling, computational geometry and automated theorem proving community may find it useful as symbolic algebraic techniques have begun to play an important role in these areas. The book, while being self-contained, is written at an advanced level and deals with the subject at an appropriate depth. The book is accessible to computer science students with no previous algebraic training. Some mathematical readers, on the other hand, may find it interesting to see how algorithmic constructions have been used to provide fresh proofs for some classical theorems. The book also contains a large number of exercises with solutions to



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selected exercises, thus making it ideal as a textbook or for self-study.

In the last few years, Algorithms for Convex Optimization have revolutionized algorithm design, both for discrete and continuous optimization problems. For problems like maximum flow, maximum matching, and submodular function minimization, the fastest algorithms involve essential methods such as gradient descent, mirror descent, interior point methods, and ellipsoid methods. The goal of this self-contained book is to enable researchers and professionals in computer science, data science, and machine learning to gain an in-depth understanding of these algorithms. The text emphasizes how to derive key algorithms for convex optimization from first principles and how to establish precise running time bounds. This modern text explains the success of these algorithms in problems of discrete optimization, as well as how these methods have significantly pushed the state of the art of convex optimization itself.

Numerical Modeling in Science and Engineering Myron B. Allen, George F. Pinder, and Ismael Herrera Emphasizing applications, this treatment combines three traditionally distinct disciplines—continuum mechanics, differential equations, and numerical analysis—to provide a unified treatment of numerical modeling of physical systems. Covers basic equations of macroscopic systems, numerical methods, steady state systems, dissipative systems, nondissipative systems, and high order, nonlinear, and coupled systems. 1988 (0 471-80635-8) 418 pp. Mathematical Modeling and Digital Simulation for Engineers and Scientists Second Edition Jon M. Smith Totally updated,

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this Second Edition reflects the many developments in simulation and computer modeling theory and practice that have occurred over the past decade. It includes a new section on the use of modern numerical methods for generating chaos and simulating random processes, a section on simulator verification, and provides applications of these methods for personal computers. Readers will find a wealth of practical fault detection and isolation techniques for simulator verification, fast functions evaluation techniques, and nested parenthetical forms and Chebyshev economization techniques. 1987 (0 471-08599-5) 430 pp. Numerical Analysis 1987 David F. Griffiths and George Alistair Watson An invaluable guide to the direction of current research in many areas of numerical analysis, this volume will be of great interest to anyone involved in software design, curve and surface fitting, the numerical solution of ordinary, partial, and integro-differential equations, and the real-world application of numerical techniques. 1988 (0 470-21012-5) 300 pp.

From the reviews: "This is a great book, which will hopefully become a classic in the subject of differential Galois theory. [...] the specialist, as well as the novice, have long been missing an introductory book covering also specific and advanced research topics. This gap is filled by the volume under review, and more than satisfactorily."

Mathematical Reviews

Modern Computer Algebra Cambridge University Press

This textbook offers an algorithmic introduction to the field of computer algebra. A

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leading expert in the field, the author guides readers through numerous hands-on tutorials designed to build practical skills and algorithmic thinking. This implementation-oriented approach equips readers with versatile tools that can be used to enhance studies in mathematical theory, applications, or teaching. Presented using Mathematica code, the book is fully supported by downloadable sessions in Mathematica, Maple, and Maxima. Opening with an introduction to computer algebra systems and the basics of programming mathematical algorithms, the book goes on to explore integer arithmetic. A chapter on modular arithmetic completes the number-theoretic foundations, which are then applied to coding theory and cryptography. From here, the focus shifts to polynomial arithmetic and algebraic numbers, with modern algorithms allowing the efficient factorization of polynomials. The final chapters offer extensions into more advanced topics: simplification and normal forms, power series, summation formulas, and integration. Computer Algebra is an indispensable resource for mathematics and computer science students new to the field. Numerous examples illustrate algorithms and their implementation throughout, with online support materials to encourage hands-on exploration. Prerequisites are minimal, with only a knowledge of calculus and linear algebra assumed. In addition to classroom use, the elementary approach and detailed index make this book an ideal reference for algorithms in computer algebra.

Mathematica, Maple, and similar software packages provide programs that carry out

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sophisticated mathematical operations. Applying the ideas introduced in *Computer Algebra and Symbolic Computation: Elementary Algorithms*, this book explores the application of algorithms to such methods as automatic simplification, polynomial decomposition, and polynomial division. Computer algebra systems are now ubiquitous in all areas of science and engineering. This highly successful textbook, widely regarded as the 'bible of computer algebra', gives a thorough introduction to the algorithmic basis of the mathematical engine in computer algebra systems. Designed to accompany one- or two-semester courses for advanced undergraduate or graduate students in computer science or mathematics, its comprehensiveness and reliability has also made it an essential reference for professionals in the area. Special features include: detailed study of algorithms including time analysis; implementation reports on several topics; complete proofs of the mathematical underpinnings; and a wide variety of applications (among others, in chemistry, coding theory, cryptography, computational logic, and the design of calendars and musical scales). A great deal of historical information and illustration enlivens the text. In this third edition, errors have been corrected and much of the Fast Euclidean Algorithm chapter has been renovated.

This Handbook gives a comprehensive snapshot of a field at the intersection of mathematics and computer science with applications in physics, engineering and education. Reviews 67 software systems and offers 100 pages on applications in physics, mathematics, computer science, engineering chemistry and education.

Solving problems in quantum mechanics is an essential skill and research activity for scientists, engineers and others. Nowadays the labor of scientific computation has been greatly eased by the advent of computer algebra packages. These do not merely perform

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number-crunching tasks, but enable users to manipulate algebraic expressions and equations symbolically. For example, differentiation and integration can now be carried out algebraically by the computer. This book collects standard and advanced methods in quantum mechanics and implements them using REDUCE, a popular computer algebra package. Throughout, sample programs and their output have been displayed alongside explanatory text, making the book easy to follow. Selected problems have also been implemented using two other popular packages, MATHEMATICA and MAPLE, and in the object-oriented programming language C++. Besides standard quantum mechanical techniques, modern developments in quantum theory are also covered. These include Fermi and Bose Operators, coherent states, gauge theory and quantum groups. All the special functions relevant to quantum mechanics (Hermite, Chebyshev, Legendre and more) are implemented. The level of presentation is such that one can get a sound grasp of computational techniques early on in one's scientific education. A careful balance is struck between practical computation and the underlying mathematical concepts, making the book well-suited for use with quantum mechanics courses.

An introductory algebra text covering commutative, non-commutative, and Boolean algebra and the lattice and Galois theories

This textbook comprehensively introduces students and researchers to the application of continuous symmetries and their Lie algebras to ordinary and partial differential equations. Covering all the modern techniques in detail, it relates applications to cutting-edge research fields such as Yang-Mills theory and string theory. Aimed at readers in applied mathematics and physics rather than pure mathematics, the material is ideally suited to students and researchers whose main interest lies in finding solutions to differential equations and invariants

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of maps. A large number of worked examples and challenging exercises help readers to work independently of teachers, and by including SymbolicC++ implementations of the techniques in each chapter, the book takes full advantage of the advancements in algebraic computation. Twelve new sections have been added in this edition, including: Haar measure, Sato's theory and sigma functions, universal algebra, anti-self dual Yang-Mills equation, and discrete Painlevé equations.

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: 9781107039032. This item is printed on demand.

Modern Computer Arithmetic focuses on arbitrary-precision algorithms for efficiently performing arithmetic operations such as addition, multiplication and division, and their connections to topics such as modular arithmetic, greatest common divisors, the Fast Fourier Transform (FFT), and the computation of elementary and special functions. Brent and Zimmermann present algorithms that are ready to implement in your favourite language, while keeping a high-level description and avoiding too low-level or machine-dependent details. The book is intended for anyone interested in the design and implementation of efficient high-precision algorithms for computer arithmetic, and more generally efficient multiple-precision numerical algorithms. It may also be used in a graduate course in mathematics or computer science, for which exercises are included. These vary considerably in difficulty, from easy to small research projects, and expand on topics discussed in the text. Solutions to selected exercises are available from the authors.

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Written by experts in both mathematics and biology, Algebraic and Discrete Mathematical Methods for Modern Biology offers a bridge between math and biology, providing a framework for simulating, analyzing, predicting, and modulating the behavior of complex biological systems. Each chapter begins with a question from modern biology, followed by the description of certain mathematical methods and theory appropriate in the search of answers. Every topic provides a fast-track pathway through the problem by presenting the biological foundation, covering the relevant mathematical theory, and highlighting connections between them. Many of the projects and exercises embedded in each chapter utilize specialized software, providing students with much-needed familiarity and experience with computing applications, critical components of the "modern biology" skill set. This book is appropriate for mathematics courses such as finite mathematics, discrete structures, linear algebra, abstract/modern algebra, graph theory, probability, bioinformatics, statistics, biostatistics, and modeling, as well as for biology courses such as genetics, cell and molecular biology, biochemistry, ecology, and evolution. Examines significant questions in modern biology and their mathematical treatments Presents important mathematical concepts and tools in the context of essential biology Features material of interest to students in both mathematics and biology Presents

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chapters in modular format so coverage need not follow the Table of Contents  
Introduces projects appropriate for undergraduate research Utilizes freely accessible software for visualization, simulation, and analysis in modern biology  
Requires no calculus as a prerequisite Provides a complete Solutions Manual  
Features a companion website with supplementary resources  
New and classical results in computational complexity, including interactive proofs, PCP, derandomization, and quantum computation. Ideal for graduate students.

This introduction to polynomial rings, Gröbner bases and applications bridges the gap in the literature between theory and actual computation. It details numerous applications, covering fields as disparate as algebraic geometry and financial markets. To aid in a full understanding of these applications, more than 40 tutorials illustrate how the theory can be used. The book also includes many exercises, both theoretical and practical.

This book presents a large number of computer algebra worksheets or "recipes" that have been designed using MAPLE to provide tools for problem solving and to stimulate critical thinking. No prior knowledge of MAPLE is necessary. All relevant commands are introduced on a need-to-know basis and are indexed for easy reference. Each recipe features a scientific model or method and an



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interesting or amusing story designed to both entertain and enhance concept comprehension and retention.

This book takes a unique approach to information retrieval by laying down the foundations for a modern algebra of information retrieval based on lattice theory. All major retrieval methods developed so far are described in detail, along with Web retrieval algorithms, and the author shows that they all can be treated elegantly in a unified formal way, using lattice theory as the one basic concept. The book's presentation is characterized by an engineering-like approach.

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