

abstract algebra theory and applications

Abstract Algebra: Theory and Applications - Unlocking the Secrets of Structure

Introduction:

Are you intrigued by the hidden structures underlying seemingly disparate mathematical concepts? Do you crave a deeper understanding of the fundamental building blocks of mathematics? Then welcome to the fascinating world of abstract algebra! This comprehensive guide delves into the core theories of abstract algebra and explores its surprisingly diverse applications across various scientific fields. We'll unravel the complexities of groups, rings, and fields, demonstrating their power and elegance through real-world examples. Forget dry textbook definitions; we'll make abstract algebra approachable and relevant, showing why it's far more than just theoretical musings. Get ready to unlock the secrets of structure and discover the power of abstract algebra.

1. Understanding the Fundamentals: What is Abstract Algebra?

Abstract algebra transcends the concrete numbers and equations of elementary algebra. Instead, it focuses on the structure of mathematical objects and the relationships between them. We move from specific calculations to general properties, exploring the underlying patterns that govern diverse mathematical systems. This shift allows us to develop powerful theorems and techniques applicable across various domains. Think of it as learning the grammar of mathematics, enabling you to understand and build far more complex sentences (mathematical systems) than you could before.

Key concepts introduced at this fundamental level include:

Sets and Operations: The foundation upon which abstract algebra is built. We examine sets, their properties (like cardinality and subsets), and operations defined on these sets (like addition, multiplication, or more abstract operations).

Binary Operations: Operations that combine two elements of a set to produce a third element within the same set. We study their properties like associativity, commutativity, and the existence of identity and inverse elements. These properties are crucial for defining the structures we'll explore later.

Isomorphisms and Homomorphisms: These concepts explore mappings between algebraic structures, revealing fundamental relationships between seemingly different systems. They help us understand when two systems are essentially the "same" from an algebraic perspective, even if their elements look different.

2. Groups: The Building Blocks of Symmetry and Structure

Groups are arguably the most fundamental algebraic structure. A group is a set equipped with a binary operation that satisfies four specific axioms: closure, associativity, identity, and invertibility. These axioms, though seemingly simple, lead to incredibly rich mathematical consequences.

We'll explore:

Group Axioms and Examples: We'll dissect each axiom, providing numerous examples of groups, ranging from familiar number systems (integers under addition) to less intuitive examples like symmetry groups of geometric shapes.

Subgroups and Cosets: Exploring the internal structure of groups by examining their subgroups and the cosets that partition the group. This analysis provides insights into the group's overall structure and symmetry.

Group Homomorphisms and Isomorphisms: Examining mappings between groups, revealing relationships and allowing for classification of different groups.

Lagrange's Theorem: A cornerstone result in group theory, showing the relationship between the order of a group and the order of its subgroups.

3. Rings and Fields: Expanding the Algebraic Landscape

Beyond groups, we delve into rings and fields, which incorporate additional operations and axioms. Rings are sets with two operations (usually addition and multiplication) satisfying certain properties. Fields are a special type of ring where every non-zero element has a multiplicative inverse.

This section covers:

Ring Axioms and Examples: Exploring the axioms defining rings (commutative rings, rings with unity, integral domains) and providing illustrative examples, including polynomial rings and matrix rings.

Ideals and Quotient Rings: Introducing ideals, which are special subsets of rings, and constructing quotient rings, which are new rings built from the original ring and its ideals. This construction is vital in understanding the structure of rings.

Field Axioms and Examples: Investigating fields, which are rings with additional properties, such as every nonzero element having a multiplicative inverse. Familiar examples include rational numbers, real numbers, and complex numbers.

Polynomial Rings and Field Extensions: Exploring polynomial rings over fields and the construction of field extensions, which are crucial in areas like Galois theory.

4. Applications of Abstract Algebra: Beyond the Theoretical

Abstract algebra's power lies not just in its elegant theory but also in its broad applicability across various fields:

Cryptography: Group theory forms the backbone of many modern cryptographic systems, ensuring secure communication and data protection. The use of finite fields in public-key cryptography is a prime example.

Coding Theory: Abstract algebra is crucial in designing error-correcting codes, essential for reliable data transmission in various applications, from satellite communication to data storage.

Physics: Symmetry groups play a pivotal role in theoretical physics, particularly in quantum mechanics and particle physics, helping to classify particles and predict their behavior.

Computer Science: Abstract algebra underpins concepts in computer algebra systems and algorithms, enabling efficient computations and solving complex problems.

5. A Suggested Textbook Outline:

Title: Abstract Algebra: A Comprehensive Introduction

Introduction: A gentle introduction to the subject, covering sets, relations, functions, and basic proof techniques.

Chapter 1: Group Theory: Detailed coverage of group axioms, subgroups, cosets, Lagrange's theorem, homomorphisms, and isomorphism theorems. Includes numerous examples and exercises.

Chapter 2: Ring Theory: A thorough exploration of ring axioms, ideals, quotient rings, prime and maximal ideals, polynomial rings, and field extensions.

Chapter 3: Field Theory: Focus on field extensions, Galois theory (basic concepts), and applications to polynomial equations.

Chapter 4: Applications: Case studies showcasing the applications of abstract algebra in cryptography, coding theory, and other areas.

Conclusion: Summary of key concepts and a look toward more advanced topics.

Detailed Explanation of Textbook Outline Points:

The introduction should set the stage by providing a clear explanation of what abstract algebra is and why it is important. It should build a foundation for understanding the core concepts that will be covered in later chapters. This includes reviewing essential prerequisite material like sets, functions, and basic proof writing techniques.

Chapter 1 on Group Theory would begin by defining the axioms of a group, providing numerous examples to illustrate these axioms. It would then delve into the internal structure of groups by exploring subgroups, cosets, and Lagrange's theorem. The concepts of group homomorphisms and isomorphisms are also crucial, demonstrating how different groups can be related.

Chapter 2, focusing on Ring Theory, expands the concepts from group theory by introducing rings, which have two operations rather than one. It covers the various types of rings (commutative, rings with unity, integral domains) and explores their properties, especially the notion of ideals and quotient rings. Polynomial rings are an essential topic, providing many important examples.

Chapter 3 delves into Field Theory, building upon the knowledge of rings. It will define fields and focus on field extensions, which are crucial for understanding the structure of fields and the solutions to polynomial equations. The basics of Galois theory, a powerful connection between field extensions and group theory, can be introduced here, although a full treatment might be reserved for a more advanced text.

Chapter 4 is dedicated to showcasing the applicability of abstract algebra in diverse fields. This chapter should present detailed case studies that highlight the real-world relevance of abstract algebra concepts. The examples should be chosen to be both interesting and illustrative, demonstrating the power of abstract algebra in solving practical problems.

The conclusion summarizes the key concepts and theorems covered throughout the book, reiterating the significance of abstract algebra within mathematics and its diverse applications. It can also serve as a bridge to more advanced topics in abstract algebra, such as representation theory or advanced Galois theory.

FAQs:

1. What is the difference between abstract algebra and linear algebra? While both are branches of algebra, abstract algebra deals with general algebraic structures (groups, rings, fields), while linear algebra focuses specifically on vector spaces and linear transformations.
1. Is abstract algebra difficult to learn? Abstract algebra requires a strong foundation in mathematical reasoning and proof techniques. It's conceptually challenging but rewarding for those willing to put in the effort.
1. What are the prerequisites for studying abstract algebra? A solid understanding of introductory algebra, basic set theory, and some familiarity with proof writing are usually necessary.
1. Why should I study abstract algebra? Abstract algebra develops critical thinking skills, enhances problem-solving abilities, and provides a powerful framework for understanding many areas of mathematics and science.
1. What are some real-world applications of abstract algebra? Cryptography, coding theory, computer science, and physics all utilize concepts from abstract algebra.
1. Are there different types of abstract algebra? Yes, the field is vast and includes areas like group theory, ring theory, field theory, module theory, and Galois theory.
1. What software is used for abstract algebra computations? Software like GAP (Groups, Algorithms, Programming) and SageMath are commonly used for computations in abstract algebra.
1. What are some good resources for learning abstract algebra? Textbooks like Dummit & Foote's "Abstract Algebra" and Fraleigh's "A First Course in Abstract Algebra" are popular choices. Online resources like Khan Academy also offer introductory materials.

1. How long does it take to master abstract algebra? It varies depending on individual learning styles and prior mathematical background, but a thorough understanding takes dedication and time – likely several semesters of study.

Related Articles:

1. Introduction to Group Theory: A beginner's guide to the fundamental concepts of group theory, focusing on group axioms, subgroups, and examples.
1. Understanding Ring Theory: An exploration of ring axioms, ideals, and quotient rings, with examples and applications.
1. Field Extensions and Galois Theory (Beginner's Guide): An introduction to the concepts of field extensions and the basic principles of Galois theory.
1. Applications of Group Theory in Cryptography: A detailed look at how group theory is used in modern cryptographic systems.
1. Error-Correcting Codes and Abstract Algebra: An explanation of how abstract algebra is used in the design of error-correcting codes.
1. Symmetry Groups in Physics: An exploration of the role of symmetry groups in various areas of physics.
1. Abstract Algebra and Computer Algebra Systems: How abstract algebra concepts are implemented in computer algebra systems for efficient computation.

1. Solving Polynomial Equations using Galois Theory: A discussion of how Galois theory provides insights into solving polynomial equations.

1. Advanced Topics in Abstract Algebra: A preview of more advanced topics in abstract algebra, such as representation theory and Lie algebras.

abstract algebra theory and applications: Abstract Algebra Thomas Judson, 2023-08-11
Abstract Algebra: Theory and Applications is an open-source textbook that is designed to teach the principles and theory of abstract algebra to college juniors and seniors in a rigorous manner. Its strengths include a wide range of exercises, both computational and theoretical, plus many non-trivial applications. The first half of the book presents group theory, through the Sylow theorems, with enough material for a semester-long course. The second half is suitable for a second semester and presents rings, integral domains, Boolean algebras, vector spaces, and fields, concluding with Galois Theory.

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abstract algebra theory and applications: A Book of Abstract Algebra Charles C Pinter, 2010-01-14
Accessible but rigorous, this outstanding text encompasses all of the topics covered by a typical course in elementary abstract algebra. Its easy-to-read treatment offers an intuitive approach, featuring informal discussions followed by thematically arranged exercises. This second edition features additional exercises to improve student familiarity with applications. 1990 edition.

abstract algebra theory and applications: Abstract Algebra Thomas W. Judson, 2009-06-01
This text is intended for a one- or two-semester undergraduate course in abstract algebra and covers the traditional theoretical aspects of groups, rings, and fields. Many applications are included, including coding theory and cryptography. The nature of the exercises ranges over several categories; computational, conceptual, and theoretical problems are included.

abstract algebra theory and applications: Abstract Algebra Celine Carstensen-Opitz, Benjamin Fine, Anja Moldenhauer, Gerhard Rosenberger, 2019-09-02
A new approach to conveying abstract algebra, the area that studies algebraic structures, such as groups, rings, fields, modules, vector spaces, and algebras, that is essential to various scientific disciplines such as particle physics and cryptology. It provides a well written account of the theoretical foundations and it also includes a chapter on cryptography. End of chapter problems help readers with accessing the subjects.

abstract algebra theory and applications: Introduction to Modern Algebra and Its Applications Nadiya Gubareni, 2021-06-23
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 and computer graphics.

abstract algebra theory and applications: *Abstract Algebra with Applications* Audrey Terras, 2019 This text offers a friendly and concise introduction to abstract algebra, emphasizing its uses in the modern world.

abstract algebra theory and applications: *Abstract Algebra* Dan Saracino, 2008-09-02 The Second Edition of this classic text maintains the clear exposition, logical organization, and accessible breadth of coverage that have been its hallmarks. It plunges directly into algebraic structures and incorporates an unusually large number of examples to clarify abstract concepts as they arise. Proofs of theorems do more than just prove the stated results; Saracino examines them so readers gain a better impression of where the proofs come from and why they proceed as they do. Most of the exercises range from easy to moderately difficult and ask for understanding of ideas rather than flashes of insight. The new edition introduces five new sections on field extensions and Galois theory, increasing its versatility by making it appropriate for a two-semester as well as a one-semester course.

abstract algebra theory and applications: *Abstract Algebra* Derek J.S. Robinson, 2015-05-19 This is a high level introduction to abstract algebra which is aimed at readers whose interests lie in mathematics and in the information and physical sciences. In addition to introducing the main concepts of modern algebra, the book contains numerous applications, which are intended to illustrate the concepts and to convince the reader of the utility and relevance of algebra today. In particular applications to Polya coloring theory, latin squares, Steiner systems and error correcting codes are described. Another feature of the book is that group theory and ring theory are carried further than is often done at this level. There is ample material here for a two semester course in abstract algebra. The importance of proof is stressed and rigorous proofs of almost all results are given. But care has been taken to lead the reader through the proofs by gentle stages. There are nearly 400 problems, of varying degrees of difficulty, to test the reader's skill and progress. The book should be suitable for students in the third or fourth year of study at a North American university or in the second or third year at a university in Europe, and should ease the transition to (post)graduate studies.

abstract algebra theory and applications: *Abstract Algebra* David R. Finston, Patrick J. Morandi, 2014-08-29 This text seeks to generate interest in abstract algebra by introducing each new structure and topic via a real-world application. The down-to-earth presentation is accessible to a readership with no prior knowledge of abstract algebra. Students are led to algebraic concepts and questions in a natural way through their everyday experiences. Applications include: Identification numbers and modular arithmetic (linear) error-correcting codes, including cyclic codes ruler and compass constructions cryptography symmetry of patterns in the real plane *Abstract Algebra: Structure and Application* is suitable as a text for a first course on abstract algebra whose main purpose is to generate interest in the subject or as a supplementary text for more advanced courses. The material paves the way to subsequent courses that further develop the theory of abstract algebra and will appeal to students of mathematics, mathematics education, computer science, and engineering interested in applications of algebraic concepts.

abstract algebra theory and applications: *Introduction to the Theory of Abstract Algebras* Richard S Pierce, 2015-01-21 Suitable for introductory graduate-level courses and independent study, this text presents the basic definitions of the theory of abstract algebra. Following introductory material, each of four chapters focuses on a major theme of universal algebra: subdirect decompositions, direct decompositions, free algebras, and varieties of algebra. Problems and a bibliography supplement the text. --

abstract algebra theory and applications: *A Course in Algebra* Ernest Borisovich Vinberg, 2003-04-10 Presents modern algebra. This book includes such topics as affine and projective spaces, tensor algebra, Galois theory, Lie groups, and associative algebras and their representations. It is suitable for independent study for advanced undergraduates and graduate students.

abstract algebra theory and applications: Abstract Algebra Stephen Lovett, 2015-07-13 A Discovery-Based Approach to Learning about Algebraic Structures Abstract Algebra: Structures and Applications helps students understand the abstraction of modern algebra. It emphasizes the more general concept of an algebraic structure while simultaneously covering applications. The text can be used in a variety of courses, from a one-semester int

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abstract algebra theory and applications: Visual Group Theory Nathan Carter, 2021-06-08 Recipient of the Mathematical Association of America's Beckenbach Book Prize in 2012! Group theory is the branch of mathematics that studies symmetry, found in crystals, art, architecture, music and many other contexts, but its beauty is lost on students when it is taught in a technical style that is difficult to understand. Visual Group Theory assumes only a high school mathematics background and covers a typical undergraduate course in group theory from a thoroughly visual perspective. The more than 300 illustrations in Visual Group Theory bring groups, subgroups, homomorphisms, products, and quotients into clear view. Every topic and theorem is accompanied with a visual demonstration of its meaning and import, from the basics of groups and subgroups through advanced structural concepts such as semidirect products and Sylow theory.

abstract algebra theory and applications: Algebra: Chapter 0 Paolo Aluffi, 2021-11-09 Algebra: Chapter 0 is a self-contained introduction to the main topics of algebra, suitable for a first sequence on the subject at the beginning graduate or upper undergraduate level. The primary distinguishing feature of the book, compared to standard textbooks in algebra, is the early introduction of categories, used as a unifying theme in the presentation of the main topics. A second feature consists of an emphasis on homological algebra: basic notions on complexes are presented as soon as modules have been introduced, and an extensive last chapter on homological algebra can form the basis for a follow-up introductory course on the subject. Approximately 1,000 exercises both provide adequate practice to consolidate the understanding of the main body of the text and offer the opportunity to explore many other topics, including applications to number theory and algebraic geometry. This will allow instructors to adapt the textbook to their specific choice of topics and provide the independent reader with a richer exposure to algebra. Many exercises include substantial hints, and navigation of the topics is facilitated by an extensive index and by hundreds of cross-references.

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properties of the integers and equivalence relations. The author then explores the first major algebraic structure, the group, progressing as far as the Sylow theorems and the classification of finite abelian groups. An introduction to ring theory follows, leading to a discussion of fields and polynomials that includes sections on splitting fields and the construction of finite fields. The final part contains applications to public key cryptography as well as classical straightedge and compass constructions. Explaining key topics at a gentle pace, this book is aimed at undergraduate students. It assumes no prior knowledge of the subject and contains over 500 exercises, half of which have detailed solutions provided.

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 A comprehensive introduction, *Linear Algebra: Ideas and Applications*, Fourth Edition provides a discussion of the theory and applications of linear algebra that blends abstract and computational concepts. With a focus on the development of mathematical intuition, the book emphasizes the need to understand both the applications of a particular technique and the mathematical ideas underlying the technique. The book introduces each new concept in the context of an explicit numerical example, which allows the abstract concepts to grow organically out of the necessity to solve specific problems. The intuitive discussions are consistently followed by rigorous statements of results and proofs. *Linear Algebra: Ideas and Applications*, Fourth Edition also features: Two new and independent sections on the rapidly developing subject of wavelets A thoroughly updated section on electrical circuit theory Illuminating applications of linear algebra with self-study questions for additional study End-of-chapter summaries and sections with true-false questions to aid readers with further comprehension of the presented material Numerous computer exercises throughout using MATLAB® code
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 Understanding Interaction is a book that explores the interaction between people and technology, in the broader context of the relations between the human made and the natural environments. It is not just about digital technologies - our computers, smart phones, the Internet - but all our technologies such as mechanical, electrical and electronic. Our ancestors started creating mechanical tools and shaping their environments millions of years ago, developing cultures and languages, which in turn influenced our evolution. Volume 1 of Understanding Interaction looks into this deep history - starting from the tool creating period (the longest and most influential on our physical and mental capacities), to the settlement period (agriculture, domestication, villages and cities, written language), the industrial period (science, engineering, reformation and renaissance), and finally the communication period (mass media, digital technologies, global networks). Volume 2 looks into humans in interaction - our physiology, anatomy, neurology, psychology, how we experience and influence the world, and how we (think we) think. From this transdisciplinary understanding, design approaches and frameworks are presented, to potentially guide future developments and innovations. The aim of the book is to be guide and inspiration for designers, artists, engineers, psychologists, media producers, social scientists etc., and as such be useful for both novices and more experienced practitioners.

abstract algebra theory and applications: A Concrete Introduction to Higher Algebra Lindsay Childs, 2012-12-06
 This book is written as an introduction to higher algebra for students with a background of a year of calculus. The book developed out of a set of notes for a sophomore-junior level course at the State University of New York at Albany entitled Classical Algebra. In the 1950s and before, it was customary for the first course in algebra to be a course in the theory of equations, consisting of a study of polynomials over the complex, real, and rational

numbers, and, to a lesser extent, linear algebra from the point of view of systems of equations. Abstract algebra, that is, the study of groups, rings, and fields, usually followed such a course. In recent years the theory of equations course has disappeared. Without it, students entering abstract algebra courses tend to lack the experience in the algebraic theory of the basic classical examples of the integers and polynomials necessary for understanding, and more importantly, for appreciating the formalism. To meet this problem, several texts have recently appeared introducing algebra through number theory.

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abstract algebra theory and applications: Matrix Algebra James E. Gentle, 2007-07-27 Matrix algebra is one of the most important areas of mathematics for data analysis and for statistical theory. This much-needed work presents the relevant aspects of the theory of matrix algebra for applications in statistics. It moves on to consider the various types of matrices encountered in statistics, such as projection matrices and positive definite matrices, and describes the special properties of those matrices. Finally, it covers numerical linear algebra, beginning with a discussion of the basics of numerical computations, and following up with accurate and efficient algorithms for factoring matrices, solving linear systems of equations, and extracting eigenvalues and eigenvectors.

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abstract algebra theory and applications: Algebraic Statistics Seth Sullivant, 2018-11-19 Algebraic statistics uses tools from algebraic geometry, commutative algebra, combinatorics, and their computational sides to address problems in statistics and its applications. The starting point for this connection is the observation that many statistical models are semialgebraic sets. The algebra/statistics connection is now over twenty years old, and this book presents the first broad introductory treatment of the subject. Along with background material in probability, algebra, and statistics, this book covers a range of topics in algebraic statistics including algebraic exponential families, likelihood inference, Fisher's exact test, bounds on entries of contingency tables, design of experiments, identifiability of hidden variable models, phylogenetic models, and model selection. With numerous examples, references, and over 150 exercises, this book is suitable for both classroom use and independent study.

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2012-12-06 This elementary presentation exposes readers to both the process of rigor and the rewards inherent in taking an axiomatic approach to the study of functions of a real variable. The aim is to challenge and improve mathematical intuition rather than to verify it. The philosophy of this book is to focus attention on questions which give analysis its inherent fascination. Each chapter begins with the discussion of some motivating examples and concludes with a series of questions.

abstract algebra theory and applications: Applications of Abstract Algebra with MAPLE Richard Klima, Neil P. Sigmon, Ernest Stitzinger, 1999-09-28 The mathematical concepts of abstract algebra may indeed be considered abstract, but its utility is quite concrete and continues to grow in importance. Unfortunately, the practical application of abstract algebra typically involves extensive and cumbersome calculations-often frustrating even the most dedicated attempts to appreciate and employ its intricacies. Now, however, sophisticated mathematical software packages help obviate the need for heavy number-crunching and make fields dependent on the algebra more interesting-and more accessible. Applications of Abstract Algebra with Maple opens the door to cryptography, coding, Polya counting theory, and the many other areas dependent on abstract algebra. The authors have carefully integrated Maple V throughout the text, enabling readers to see realistic examples of the topics discussed without struggling with the computations. But the book stands well on its own if the reader does not have access to the software. The text includes a first-chapter review of the mathematics required-groups, rings, and finite fields-and a Maple tutorial in the appendix along with detailed treatments of coding, cryptography, and Polya theory applications. Applications of Abstract Algebra with Maple packs a double punch for those interested in beginning-or advancing-careers related to the applications of abstract algebra. It not only provides an in-depth introduction to the fascinating, real-world problems to which the algebra applies, it offers readers the opportunity to gain experience in using one of the leading and most respected mathematical software packages available.

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abstract algebra theory and applications: Semirings: Algebraic Theory And Applications In Computer Science Hanns Joachim Weinert, 1998-10-30 This book provides an introduction to the algebraic theory of semirings and, in this context, to basic algebraic concepts as e.g. semigroups, lattices and rings. It includes an algebraic theory of infinite sums as well as a detailed treatment of

several applications in theoretical computer science. Complete proofs, various examples and exercises (some of them with solutions) make the book suitable for self-study. On the other hand, a more experienced reader who looks for information about the most common concepts and results on semirings will find cross-references throughout the book, a comprehensive bibliography and various hints to it.

abstract algebra theory and applications: *Introduction to Abstract Algebra* Benjamin Fine, Anthony M. Gaglione, Gerhard Rosenberger, 2014-07-01 A new approach to abstract algebra that eases student anxieties by building on fundamentals. *Introduction to Abstract Algebra* presents a breakthrough approach to teaching one of math's most intimidating concepts. Avoiding the pitfalls common in the standard textbooks, Benjamin Fine, Anthony M. Gaglione, and Gerhard Rosenberger set a pace that allows beginner-level students to follow the progression from familiar topics such as rings, numbers, and groups to more difficult concepts. Classroom tested and revised until students achieved consistent, positive results, this textbook is designed to keep students focused as they learn complex topics. Fine, Gaglione, and Rosenberger's clear explanations prevent students from getting lost as they move deeper and deeper into areas such as abelian groups, fields, and Galois theory. This textbook will help bring about the day when abstract algebra no longer creates intense anxiety but instead challenges students to fully grasp the meaning and power of the approach. Topics covered include: • Rings • Integral domains • The fundamental theorem of arithmetic • Fields • Groups • Lagrange's theorem • Isomorphism theorems for groups • Fundamental theorem of finite abelian groups • The simplicity of A_n for $n \geq 5$ • Sylow theorems • The Jordan-Hölder theorem • Ring isomorphism theorems • Euclidean domains • Principal ideal domains • The fundamental theorem of algebra • Vector spaces • Algebras • Field extensions: algebraic and transcendental • The fundamental theorem of Galois theory • The unsolvability of the quintic

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