Discrete Mathematics Using Latin Squares By Charles F Laywine 1998 09 03

SIAM Journal on Algebraic and Discrete MethodsCombinatorial MathematicsDiscrete Geometry and Algebraic CombinatoricsLinear Algebra Research AdvancesCombinatorial Methods in Discrete MathematicsCombinatorial DesignsOrthogonal ArraysOrthogonal Latin Squares Based on GroupsInvitation to Discrete MathematicsCombinatory AnalysisCombinatorial Mathematics XCRC Handbook of Combinatorial DesignsComputational Discrete MathematicsHandbook of Combinatorial DesignsPrinciples and Practice of Constraint ProgrammingIntroduction to CombinatoricsCombinatorial TheoryResources for Teaching Discrete MathematicsLatin SquaresCombinatorics: Ancient & ModernDiscrete Mathematics with ProofLatin SquaresAlgebraic and Geometric CombinatoricsCombinatorial Methods with Computer ApplicationsMathematische Unterhaltungen und SpieleApplied Abstract AlgebraLatin Squares and Their ApplicationsDiscrete Mathematics with ProofGraph Theory and Combinatorics 1988A First Course in Discrete MathematicsMathematical ReviewsDiscrete MathematicsCombinatorics '84Discrete MathematicsDesigns and GraphsCombinatorial DesignsCombinatorial Design TheoryDiscrete Mathematics Using Latin SquaresDesign TheoryDiscrete Mathematics Using a Computer

SIAM Journal on Algebraic and Discrete Methods

This volume contains the proceedings of the AMS Special Session on Discrete Geometry and Algebraic Combinatorics held on January 11, 2013, in San Diego, California. The collection of articles in this volume is devoted to packings of metric spaces and related questions, and contains new results as well as surveys of some areas of discrete geometry. This volume consists of papers on combinatorics of transportation polytopes, including results on the diameter of graphs of such polytopes; the generalized Steiner problem and related topics of the minimal fillings theory; a survey of distance graphs and graphs of diameters, and a group of papers on applications of algebraic combinatorics to packings of metric spaces including sphere packings and topics in coding theory. In particular, this volume presents a new approach to duality in sphere packing based on the Poisson summation formula, applications of semidefinite programming to spherical codes and equiangular lines, new results in list decoding of a family of algebraic codes, and constructions of bent and semi-bent functions.

Combinatorial Mathematics

Drawing on many years'experience of teaching discrete mathem atics to students of all levels, Anderson introduces such as pects as enumeration,

graph theory and configurations or arr angements. Starting with an introduction to counting and rel ated problems, he moves on to the basic ideas of graph theor y with particular emphasis on trees and planar graphs. He de scribes the inclusion-exclusion principle followed by partit ions of sets which in turn leads to a study of Stirling and Bell numbers. Then follows a treatment of Hamiltonian cycles, Eulerian circuits in graphs, and Latin squares as well as proof of Hall's theorem. He concludes with the constructions of schedules and a brief introduction to block designs. Each chapter is backed by a number of examples, with straightforw ard applications of ideas and more challenging problems.

Discrete Geometry and Algebraic Combinatorics

Aimed at undergraduate mathematics and computer science students, this book is an excellent introduction to a lot of problems of discrete mathematics. It discusses a number of selected results and methods, mostly from areas of combinatorics and graph theory, and it uses proofs and problem solving to help students understand the solutions to problems. Numerous examples, figures, and exercises are spread throughout the book.

Linear Algebra Research Advances

A Trusted Guide to Discrete Mathematics with Proof?Now in a Newly Revised Edition Discrete mathematics has become increasingly popular in

recent years due to its growing applications in the field of computer science. Discrete Mathematics with Proof, Second Edition continues to facilitate an up-to-date understanding of this important topic, exposing readers to a wide range of modern and technological applications. The book begins with an introductory chapter that provides an accessible explanation of discrete mathematics. Subsequent chapters explore additional related topics including counting, finite probability theory, recursion, formal models in computer science, graph theory, trees, the concepts of functions, and relations. Additional features of the Second Edition include: An intense focus on the formal settings of proofs and their techniques, such as constructive proofs, proof by contradiction, and combinatorial proofs New sections on applications of elementary number theory, multidimensional induction, counting tulips, and the binomial distribution Important examples from the field of computer science presented as applications including the Halting problem, Shannon's mathematical model of information, regular expressions, XML, and Normal Forms in relational databases Numerous examples that are not often found in books on discrete mathematics including the deferred acceptance algorithm, the Boyer-Moore algorithm for pattern matching, Sierpinski curves, adaptive quadrature, the Josephus problem, and the five-color theorem Extensive appendices that outline supplemental material on analyzing claims and writing mathematics, along with solutions to selected chapter exercises Combinatorics receives a full chapter treatment that extends beyond the combinations and permutations material by delving into non-standard

topics such as Latin squares, finite projective planes, balanced incomplete block designs, coding theory, partitions, occupancy problems, Stirling numbers, Ramsey numbers, and systems of distinct representatives. A related Web site features animations and visualizations of combinatorial proofs that assist readers with comprehension. In addition, approximately 500 examples and over 2,800 exercises are presented throughout the book to motivate ideas and illustrate the proofs and conclusions of theorems. Assuming only a basic background in calculus, Discrete Mathematics with Proof, Second Edition is an excellent book for mathematics and computer science courses at the undergraduate level. It is also a valuable resource for professionals in various technical fields who would like an introduction to discrete mathematics.

Combinatorial Methods in Discrete Mathematics

Combinatorial Designs

Orthogonal Arrays

Several areas of mathematics find application throughout computer science, and all students of computer science need a practical working understanding of them. These core subjects are centred on logic, sets, recursion, induction, relations and functions. The material is often called discrete

mathematics, to distinguish it from the traditional topics of continuous mathematics such as integration and differential equations. The central theme of this book is the connection between computing and discrete mathematics. This connection is useful in both directions: • Mathematics is used in many branches of computer science, in applica tions including program specification, datastructures,design and analysis of algorithms, database systems, hardware design, reasoning about the correctness of implementations, and much more; • Computers can help to make the mathematics easier to learn and use, by making mathematical terms executable, making abstract concepts more concrete, and through the use of software tools such as proof checkers. These connections are emphasised throughout the book. Software tools (see Appendix A) enable the computer to serve as a calculator, but instead of just doing arithmetic and trigonometric functions, it will be used to calculate with sets, relations, functions, predicates and inferences. There are also special software tools, for example a proof checker for logical proofs using natural deduction.

Orthogonal Latin Squares Based on Groups

This monograph presents a unified exposition of latin squares and mutually orthogonal sets of latin squares based on groups. Its focus is on orthomorphisms and complete mappings of finite groups, while also offering a complete proof of the Hall–Paige conjecture. The use of latin squares in constructions of nets,

affine planes, projective planes, and transversal designs also motivates this inquiry. The text begins by introducing fundamental concepts, like the tests for determining whether a latin square is based on a group, as well as orthomorphisms and complete mappings. From there, it describes the existence problem for complete mappings of groups, building up to the proof of the Hall–Paige conjecture. The third part presents a comprehensive study of orthomorphism graphs of groups, while the last part provides a discussion of Cartesian projective planes, related combinatorial structures, and a list of open problems. Expanding the author's 1992 monograph, Orthomorphism Graphs of Groups, this book is an essential reference tool for mathematics researchers or graduate students tackling latin square problems in combinatorics. Its presentation draws on a basic understanding of finite group theory, finite field theory, linear algebra, and elementary number theory—more advanced theories are introduced in the text as needed.

Invitation to Discrete Mathematics

Continuing in the bestselling, informative tradition of the first edition, the Handbook of Combinatorial Designs, Second Edition remains the only resource to contain all of the most important results and tables in the field of combinatorial design. This handbook covers the constructions, properties, and applications of designs as well as existence

Combinatory Analysis

Combinatorial Mathematics X

Over the past two decades, research in the theory of Latin Squares has been growing at a fast pace, and new significant developments have taken place. This book offers a unique approach to various areas of discrete mathematics through the use of Latin Squares.

CRC Handbook of Combinatorial Designs

Combinatorial Methods with Computer Applications provides in-depth coverage of recurrences, generating functions, partitions, and permutations, along with some of the most interesting graph and network topics, design constructions, and finite geometries. Requiring only a foundation in discrete mathematics, it can serve as the textbook in a combinat

Computational Discrete Mathematics

Invitation to Discrete Mathematics is an introduction and a thoroughly comprehensive text at the same time. A lively and entertaining style with mathematical precision and maturity uniquely combine into an intellectual happening and should delight the interested reader. A master example of teaching contemporary discrete mathematics, and of teaching science in general.

Handbook of Combinatorial Designs

What Is Combinatorics Anyway? Broadly speaking, combinatorics is the branch of mathematics dealing with different ways of selecting objects from a set or arranging objects. It tries to answer two major kinds of questions, namely, counting questions: how many ways can a selection or arrangement be chosen with a particular set of properties; and structural questions: does there exist a selection or arrangement of objects with a particular set of properties? The authors have presented a text for students at all levels of preparation. For some, this will be the first course where the students see several real proofs. Others will have a good background in linear algebra, will have completed the calculus stream, and will have started abstract algebra. The text starts by briefly discussing several examples of typical combinatorial problems to give the reader a better idea of what the subject covers. The next chapters explore enumerative ideas and also probability. It then moves on to enumerative functions and the relations between them, and generating functions and recurrences., Important families of functions, or numbers and then theorems are presented. Brief introductions to computer algebra and group theory come next. Structures of particular interest in combinatorics: posets, graphs, codes, Latin squares, and experimental designs follow. The authors conclude with further discussion of the interaction between linear algebra and combinatorics. Features Two new chapters on probability and posets. Numerous new illustrations, exercises, and problems. More examples on current technology use A thorough focus on accuracy Three

appendices: sets, induction and proof techniques, vectors and matrices, and biographies with historical notes, Flexible use of MapleTM and MathematicaTM

Principles and Practice of Constraint Programming

Who first presented Pascal's triangle? (It was not Pascal.) Who first presented Hamiltonian graphs? (It was not Hamilton.) Who first presented Steiner triple systems? (It was not Steiner.) The history of mathematics is a well-studied and vibrant area of research, with books and scholarly articles published on various aspects of the subject. Yet, the history of combinatorics seems to have been largely overlooked. This book goes some way to redress this and serves two main purposes: 1) it constitutes the first book-length survey of the history of combinatorics; and 2) it assembles, for the first time in a single source, researches on the history of combinatorics that would otherwise be inaccessible to the general reader. Individual chapters have been contributed by sixteen experts. The book opens with an introduction by Donald E. Knuth to two thousand years of combinatorics. This is followed by seven chapters on early combinatorics, leading from Indian and Chinese writings on permutations to late-Renaissance publications on the arithmetical triangle. The next seven chapters trace the subsequent story, from Euler's contributions to such wide-ranging topics as partitions, polyhedra, and latin squares to the 20th century advances in combinatorial set theory, enumeration, and graph theory. The book concludes

with some combinatorial reflections by the distinguished combinatorialist, Peter J. Cameron. This book is not expected to be read from cover to cover, although it can be. Rather, it aims to serve as a valuable resource to a variety of audiences. Combinatorialists with little or no knowledge about the development of their subject will find the historical treatment stimulating. A historian of mathematics will view its assorted surveys as an encouragement for further research in combinatorics. The more general reader will discover an introduction to a fascinating and too little known subject that continues to stimulate and inspire the work of scholars today.

Introduction to Combinatorics

In 1974 the editors of the present volume published a well-received book entitled ``Latin Squares and their Applications''. It included a list of 73 unsolved problems of which about 20 have been completely solved in the intervening period and about 10 more have been partially solved. The present work comprises six contributed chapters and also six further chapters written by the editors themselves. As well as discussing the advances which have been made in the subject matter of most of the chapters of the earlier book, this new book contains one chapter which deals with a subject (r-orthogonal latin squares) which did not exist when the earlier book was written. The success of the former book is shown by the two or three hundred published papers which deal with questions raised by it.

Combinatorial Theory

Resources for Teaching Discrete Mathematics

In 1988, the news of Egmont Kouml;hler's untimely death at the age of 55 reached his friends and colleagues. It was widely felt that a lasting memorial tribute should be organized. The result is the present volume, containing forty-two articles, mostly in combinatorial design theory and graph theory, and all in memory of Egmont Kouml;hler. Designs and graphs were his areas of particular interest; he will long be remembered for his research on cyclic designs, Skolem sequences, t -designs and the Oberwolfach problem. Professors Lenz and Ringel give a detailed appreciation of Kouml;hler's research in the first article of this volume.There is, however, one aspect of Egmont Kouml;hler's biography that merits special attention. Before taking up the study of mathematics at the age of 31, he had completed training as a musician (studying both composition and violoncello at the Musikhochschule in Berlin), and worked as a cellist in a symphony orchestra for some years. This accounts for his interest in the combinatorial aspects of music. His work and lectures in this direction had begun to attract the interest of many musicians, and he had commenced work on a book on mathematical aspects of musical theory. It is tragic indeed that his early death prevented the completion of his work; the surviving paper on the classification and complexity of chords indicates the loss that his death meant to

the area, as he was almost uniquely qualified to bring mathematics and music together, being a professional in both fields.

Latin Squares

From experimental design to cryptography, this comprehensive, easy-to-access reference contains literally all the facts you need on combinatorial designs. It includes constructions of designs, existence results, and properties of designs. Organized into six main parts, the CRC Handbook of Combinatorial Designs covers:

Combinatorics: Ancient & Modern

In 1974 the editors of the present volume published a well-received book entitled ``Latin Squares and their Applications''. It included a list of 73 unsolved problems of which about 20 have been completely solved in the intervening period and about 10 more have been partially solved. The present work comprises six contributed chapters and also six further chapters written by the editors themselves. As well as discussing the advances which have been made in the subject matter of most of the chapters of the earlier book, this new book contains one chapter which deals with a subject (r-orthogonal latin squares) which did not exist when the earlier book was written. The success of the former book is shown by the two or three hundred published papers which deal with questions raised by it.

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Extensive appendices that outline supplemental material on analyzing claims and writing mathematics, along with solutions to selected chapter exercises Combinatorics receives a full chapter treatment that extends beyond the combinations and permutations material by delving into non-standard topics such as Latin squares, finite projective planes, balanced incomplete block designs, coding theory, partitions, occupancy problems, Stirling numbers, Ramsey numbers, and systems of distinct representatives. A related Web site features animations and visualizations of combinatorial proofs that assist readers with comprehension. In addition, approximately 500 examples and over 2,800 exercises are presented throughout the book to motivate ideas and illustrate the proofs and conclusions of theorems. Assuming only a basic background in calculus, Discrete Mathematics with Proof, Second Edition is an excellent book for mathematics and computer science courses at the undergraduate level. It is also a valuable resource for professionals in various technical fields who would like an introduction to discrete mathematics.

Latin Squares

Latin Squares and Their Applications, Second edition offers a long-awaited update and reissue of this seminal account of the subject. The revision retains foundational, original material from the frequently-cited 1974 volume but is completely updated throughout. As with the earlier version, the author hopes to take the reader ‘from the beginnings of the

subject to the frontiers of research'. By omitting a few topics which are no longer of current interest, the book expands upon active and emerging areas. Also, the present state of knowledge regarding the 73 then-unsolved problems given at the end of the first edition is discussed and commented upon. In addition, a number of new unsolved problems are proposed. Using an engaging narrative style, this book provides thorough coverage of most parts of the subject, one of the oldest of all discrete mathematical structures and still one of the most relevant. However, in consequence of the huge expansion of the subject in the past 40 years, some topics have had to be omitted in order to keep the book of a reasonable length. Latin squares, or sets of mutually orthogonal latin squares (MOLS), encode the incidence structure of finite geometries; they prescribe the order in which to apply the different treatments in designing an experiment in order to permit effective statistical analysis of the results; they produce optimal density error-correcting codes; they encapsulate the structure of finite groups and of more general algebraic objects known as quasigroups. As regards more recreational aspects of the subject, latin squares provide the most effective and efficient designs for many kinds of games tournaments and they are the templates for Sudoku puzzles. Also, they provide a number of ways of constructing magic squares, both simple magic squares and also ones with additional properties. Retains the organization and updated foundational material from the original edition Explores current and emerging research topics Includes the original 73 'Unsolved Problems' with the current state of knowledge regarding them, as well as new Unsolved

Problems for further study

Algebraic and Geometric Combinatorics

Combinatorial Methods with Computer Applications

Includes proof of van der Waerden's 1926 conjecture on permanents, Wilson's theorem on asymptotic existence, and other developments in combinatorics since 1967. Also covers coding theory and its important connection with designs, problems of enumeration, and partition. Presents fundamentals in addition to latest advances, with illustrative problems at the end of each chapter. Enlarged appendixes include a longer list of block designs.

Mathematische Unterhaltungen und Spiele

Discrete mathematics is a compulsory subject for undergraduate computer scientists. This new edition includes new chapters on statements and proof, logical framework, natural numbers and the integers and updated exercises from the previous edition.

Applied Abstract Algebra

Latin Squares and Their Applications

Algebraic and Geometric Combinatorics

Discrete Mathematics with Proof

This book is based on a graduate education program on computational discrete mathematics run for several years in Berlin, Germany, as a joint effort of theoretical computer scientists and mathematicians in order to support doctoral students and advanced ongoing education in the field of discrete mathematics and algorithmics. The 12 selected lectures by leading researchers presented in this book provide recent research results and advanced topics in a coherent and consolidated way. Among the areas covered are combinatorics, graph theory, coding theory, discrete and computational geometry, optimization, and algorithmic aspects of algebra.

Graph Theory and Combinatorics 1988

Orthogonal arrays have played a vital role in improving the quality of products manufactured throughout the world. This first book on the subject since its introduction more than fifty years ago serves as a key resource to this area of designing experiments. Most of the arrays obtained by the methods in this book are available electronically. Anyone running experiments - whether in a chemistry lab or a manufacturing plant, or in agricultural or medical research - will find this book useful.

A First Course in Discrete Mathematics

Resources for Teaching Discrete Mathematics presents nineteen classroom tested projects complete with student handouts, solutions, and notes to the instructor. Topics range from a first day activity that motivates proofs to applications of discrete mathematics to chemistry, biology, and data storage. Other projects provide: supplementary material on classic topics such as the towers of Hanoi and the Josephus problem, how to use a calculator to explore various course topics, how to employ Cuisenaire rods to examine the Fibonacci numbers and other sequences, and how you can use plastic pipes to create a geodesic dome. The book contains eleven history modules that allow students to explore topics in their original context. Sources range from eleventh century Chinese figures that prompted Leibniz to write on binary arithmetic, to a 1959 article on automata theory. Excerpts include: Pascal's "Treatise on the Arithmetical Triangle," Hamilton's "Account of the Icosian Game," and Cantor's (translated) "Contributions to the Founding of the Theory of Transfinite Numbers." Five articles complete the book. Three address extensions of standard discrete mathematics content: an exploration of historical counting problems with attention to discovering formulas, a discussion of how computers store graphs, and a survey connecting the principle of inclusion-exclusion to Möbius inversion. Finally, there are two articles on pedagogy specifically related to discrete mathematics courses: a summary of adapting a group discovery method to larger classes, and a discussion of using logic in encouraging students to construct proofs.

Mathematical Reviews

Linear algebra is the branch of mathematics concerned with the study of vectors, vector spaces (also called linear spaces), linear maps (also called linear transformations), and systems of linear equations. Vector spaces are a central theme in modern mathematics; thus, linear algebra is widely used in both abstract algebra and functional analysis. Linear algebra also has a concrete representation in analytic geometry and it is generalised in operator theory. It has extensive applications in the natural sciences and the social sciences, since non-linear models can often be approximated by linear ones.

Discrete Mathematics

Interest in combinatorial techniques has been greatly enhanced by the applications they may offer in connection with computer technology. The 38 papers in this volume survey the state of the art and report on recent results in Combinatorial Geometries and their applications. Contributors: V. Abatangelo, L. Beneteau, W. Benz, A. Beutelspacher, A. Bichara, M. Biliotti, P. Biondi, F. Bonetti, R. Capodaglio di Cocco, P.V. Ceccherini, L. Cerlienco, N. Civolani, M. de Soete, M. Deza, F. Eugeni, G. Faina, P. Filip, S. Fiorini, J.C. Fisher, M. Gionfriddo, W. Heise, A. Herzer, M. Hille, J.W.P. Hirschfield, T. Ihringer, G. Korchmaros, F. Kramer, H. Kramer, P. Lancellotti, B. Larato, D. Lenzi, A. Lizzio, G. Lo Faro, N.A. Malara, M.C. Marino, N. Melone, G. Menichetti, K. Metsch, S. Milici, G. Nicoletti, C. Pellegrino, G. Pica, F. Piras, T. Pisanski, G.-C. Rota,

A. Sappa, D. Senato, G. Tallini, J.A. Thas, N. Venanzangeli, A.M. Venezia, A.C.S. Ventre, H. Wefelscheid, B.J. Wilson, N. Zagaglia Salvi, H. Zeitler.

Combinatorics '84

Design Theory, Second Edition presents some of the most important techniques used for constructing combinatorial designs. It augments the descriptions of the constructions with many figures to help students understand and enjoy this branch of mathematics. This edition now offers a thorough development of the embedding of Latin squares and combinatorial designs. It also presents some pure mathematical ideas, including connections between universal algebra and graph designs. The authors focus on several basic designs, including Steiner triple systems, Latin squares, and finite projective and affine planes. They produce these designs using flexible constructions and then add interesting properties that may be required, such as resolvability, embeddings, and orthogonality. The authors also construct more complicated structures, such as Steiner quadruple systems. By providing both classical and state-of-the-art construction techniques, this book enables students to produce many other types of designs.

Discrete Mathematics

Combinatorics has not been an established branch of mathematics for very long: the last quarter of a century has seen an explosive growth in the subject.

This growth has been largely due to the doyen of combinatorialists, Paul Erdős, whose penetrating insight and insatiable curiosity has provided a huge stimulus for workers in the field. There is hardly any branch of combinatorics that has not been greatly enriched by his ideas. This volume is dedicated to Paul Erdős on the occasion of his seventy-fifth birthday.

Designs and Graphs

Combinatorial design theory is a vibrant area of combinatorics, connecting graph theory, number theory, geometry, and algebra with applications in experimental design, coding theory, and numerous applications in computer science. This volume is a collection of forty-one state-of-the-art research articles spanning all of combinatorial design theory. The articles develop new methods for the construction and analysis of designs and related combinatorial configurations; both new theoretical methods, and new computational tools and results, are presented. In particular, they extend the current state of knowledge on Steiner systems, Latin squares, one-factorizations, block designs, graph designs, packings and coverings, and develop recursive and direct constructions. The contributions form an overview of the current diversity of themes in design theory for those peripherally interested, while researchers in the field will find it to be a major collection of research advances. The volume is dedicated to Alex Rosa, who has played a major role in fostering and developing combinatorial design

theory.

Combinatorial Designs

Haim Hanani pioneered the techniques for constructing designs and the theory of pairwise balanced designs, leading directly to Wilson's Existence Theorem. He also led the way in the study of resolvable designs, covering and packing problems, latin squares, 3-designs and other combinatorial configurations. The Hanani volume is a collection of research and survey papers at the forefront of research in combinatorial design theory, including Professor Hanani's own latest work on Balanced Incomplete Block Designs. Other areas covered include Steiner systems, finite geometries, quasigroups, and t-designs.

Combinatorial Design Theory

Created to teach students many of the most important techniques used for constructing combinatorial designs, this is an ideal textbook for advanced undergraduate and graduate courses in combinatorial design theory. The text features clear explanations of basic designs, such as Steiner and Kirkman triple systems, mutual orthogonal Latin squares, finite projective and affine planes, and Steiner quadruple systems. In these settings, the student will master various construction techniques, both classic and modern, and will be well-prepared to construct a vast array of combinatorial designs. Design theory offers a progressive approach to the

subject, with carefully ordered results. It begins with simple constructions that gradually increase in complexity. Each design has a construction that contains new ideas or that reinforces and builds upon similar ideas previously introduced. A new text/reference covering all apsects of modern combinatorial design theory. Graduates and professionals in computer science, applied mathematics, combinatorics, and applied statistics will find the book an essential resource.

Discrete Mathematics Using Latin Squares

Accessible to junior and senior undergraduate students, this survey contains many examples, solved exercises, sets of problems, and parts of abstract algebra of use in many other areas of discrete mathematics. Although this is a mathematics book, the authors have made great efforts to address the needs of users employing the techniques discussed. Fully worked out computational examples are backed by more than 500 exercises throughout the 40 sections. This new edition includes a new chapter on cryptology, and an enlarged chapter on applications of groups, while an extensive chapter has been added to survey other applications not included in the first edition. The book assumes knowledge of the material covered in a course on linear algebra and, preferably, a first course in (abstract) algebra covering the basics of groups, rings, and fields.

Design Theory

A 1996 account of some complex problems of discrete mathematics in a simple and unified form.

Discrete Mathematics Using a Computer

The object of this book is to provide an account of the results and methods used in combinatorial theories: Graph Theory, Matching Theory, Hamiltonian Problems, Hypergraph Theory, Designs, Steiner Systems, Latin Squares, Coding Matroids, Complexity Theory. In publishing this volume, the editors do not intend to discuss all the classical open problems in combinatorics for which an algebraic approach turns out to be useful. The work is a selection which is intended for specialists, as well as for graduate students who may also be interested in survey papers. The work features a special section which contains a list of unsolved problems proposed by the participants.