Undergraduate Texts in Mathematics



Richard P. Stanley

Algebraic Combinatorics

Walks, Trees, Tableaux, and More



Christopher David Godsil

Algebraic Combinatorics Richard P. Stanley, 2013-06-17 Written by one of the foremost experts in the field Algebraic Combinatorics is a unique undergraduate textbook that will prepare the next generation of pure and applied mathematicians The combination of the author's extensive knowledge of combinatorics and classical and practical tools from algebra will inspire motivated students to delve deeply into the fascinating interplay between algebra and combinatorics Readers will be able to apply their newfound knowledge to mathematical engineering and business models. The text is primarily intended for use in a one semester advanced undergraduate course in algebraic combinatorics enumerative combinatorics or graph theory Prerequisites include a basic knowledge of linear algebra over a field existence of finite fields and group theory The topics in each chapter build on one another and include extensive problem sets as well as hints to selected exercises Key topics include walks on graphs cubes and the Radon transform the Matrix Tree Theorem and the Sperner property There are also three appendices on purely enumerative aspects of combinatorics related to the chapter material the RSK algorithm plane partitions and the enumeration of labeled trees Richard Stanley is currently professor of Applied Mathematics at the Massachusetts Institute of Technology Stanley has received several awards including the George Polya Prize in applied combinatorics the Guggenheim Fellowship and the Leroy P Steele Prize for mathematical exposition Also by the author Algebraic Combinatorics Richard Combinatorics and Commutative Algebra Second Edition Birkhauser Stanley, 2013-06-18 Written by one of the foremost experts in the field Algebraic Combinatorics is a unique undergraduate textbook that will prepare the next generation of pure and applied mathematicians. The combination of the author's extensive knowledge of combinatorics and classical and practical tools from algebra will inspire motivated students to delve deeply into the fascinating interplay between algebra and combinatorics Readers will be able to apply their newfound knowledge to mathematical engineering and business models The text is primarily intended for use in a one semester advanced undergraduate course in algebraic combinatorics enumerative combinatorics or graph theory Prerequisites include a basic knowledge of linear algebra over a field existence of finite fields and group theory. The topics in each chapter build on one another and include extensive problem sets as well as hints to selected exercises Key topics include walks on graphs cubes and the Radon transform the Matrix Tree Theorem and the Sperner property There are also three appendices on purely enumerative aspects of combinatorics related to the chapter material the RSK algorithm plane partitions and the enumeration of labeled trees Richard Stanley is currently professor of Applied Mathematics at the Massachusetts Institute of Technology Stanley has received several awards including the George Polya Prize in applied combinatorics the Guggenheim Fellowship and the Leroy P Steele Prize for mathematical exposition Also by the author Combinatorics and Commutative Algebra Second Edition Birkhauser Algebraic Combinatorics Richard P. Stanley, 2018-06-06 Written by one of the foremost experts in the field Algebraic Combinatorics is a unique undergraduate textbook that will prepare the next

generation of pure and applied mathematicians The combination of the author's extensive knowledge of combinatorics and classical and practical tools from algebra will inspire motivated students to delve deeply into the fascinating interplay between algebra and combinatorics Readers will be able to apply their newfound understanding to mathematical engineering and business models Prerequisites include a basic knowledge of linear algebra over a field existence of finite fields and rudiments of group theory The topics in each chapter build on one another and include extensive problem sets as well as hints to selected exercises Key topics include walks on graphs cubes and the Radon transform the Matrix Tree Theorem de Bruijn sequences the Erd's Moser conjecture electrical networks the Sperner property shellability of simplicial complexes and face rings There are also three appendices on purely enumerative aspects of combinatorics related to the chapter material the RSK algorithm plane partitions and the enumeration of labeled trees The new edition contains a bit more content than intended for a one semester advanced undergraduate course in algebraic combinatorics enumerative combinatorics or graph theory Instructors may pick and choose chapters sections for course inclusion and students can immerse themselves in exploring additional gems once the course has ended A chapter on combinatorial commutative algebra Chapter 12 is the heart of added material in this new edition. The author gives substantial application without requisites needed for algebraic topology and homological algebra A sprinkling of additional exercises and a new section 13 8 involving commutative algebra have been added From reviews of the first edition This gentle book provides the perfect stepping stone up The various chapters treat diverse topics Stanley's emphasis on gems unites all this he chooses his material to excite students and draw them into further study Summing Up Highly recommended Upper division undergraduates and above D V Feldman Choice Vol 51 8 April 2014 Pattern Recognition on Oriented Matroids Andrey O. Matveev, 2017-09-11 Pattern Recognition on Oriented Matroids covers a range of innovative problems in combinatorics poset and graph theories optimization and number theory that constitute a far reaching extension of the arsenal of committee methods in pattern recognition The groundwork for the modern committee theory was laid in the mid 1960s when it was shown that the familiar notion of solution to a feasible system of linear inequalities has ingenious analogues which can serve as collective solutions to infeasible systems A hierarchy of dialects in the language of mathematics for instance open cones in the context of linear inequality systems regions of hyperplane arrangements and maximal covectors or topes of oriented matroids provides an excellent opportunity to take a fresh look at the infeasible system of homogeneous strict linear inequalities the standard working model for the contradictory two class pattern recognition problem in its geometric setting The universal language of oriented matroid theory considerably simplifies a structural and enumerative analysis of applied aspects of the infeasibility phenomenon The present book is devoted to several selected topics in the emerging theory of pattern recognition on oriented matroids the questions of existence and applicability of matroidal generalizations of committee decision rules and related graph theoretic constructions to oriented matroids with very weak restrictions on their

structural properties a study in which in particular interesting subsequences of the Farey sequence appear naturally of the hierarchy of the corresponding tope committees a description of the three tope committees that are the most attractive approximation to the notion of solution to an infeasible system of linear constraints an application of convexity in oriented matroids as well as blocker constructions in combinatorial optimization and in poset theory to enumerative problems on tope committees an attempt to clarify how elementary changes one element reorientations in an oriented matroid affect the family of its tope committees a discrete Fourier analysis of the important family of critical tope committees through rank and distance relations in the tope poset and the tope graph the characterization of a key combinatorial role played by the symmetric cycles in hypercube graphs Contents Oriented Matroids the Pattern Recognition Problem and Tope Committees Boolean Intervals Dehn Sommerville Type Relations Farey Subsequences Blocking Sets of Set Families and Absolute Blocking Constructions in Posets Committees of Set Families and Relative Blocking Constructions in Posets Layers of Tope Committees Three Tope Committees Halfspaces Convex Sets and Tope Committees Tope Committees and Reorientations of Oriented Matroids Topes and Critical Committees Critical Committees and Distance Signals Symmetric Cycles in the Hypercube Graphs Divisors and Sandpiles Scott Corry, David Perkinson, 2018-07-23 Divisors and Sandpiles provides an introduction to the combinatorial theory of chip firing on finite graphs Part 1 motivates the study of the discrete Laplacian by introducing the dollar game The resulting theory of divisors on graphs runs in close parallel to the geometric theory of divisors on Riemann surfaces and Part 1 culminates in a full exposition of the graph theoretic Riemann Roch theorem due to M Baker and S Norine The text leverages the reader s understanding of the discrete story to provide a brief overview of the classical theory of Riemann surfaces Part 2 focuses on sandpiles which are toy models of physical systems with dynamics controlled by the discrete Laplacian of the underlying graph The text provides a careful introduction to the sandpile group and the abelian sandpile model leading ultimately to L Levine's threshold density theorem for the fixed energy sandpile Markov chain In a precise sense the theory of sandpiles is dual to the theory of divisors and there are many beautiful connections between the first two parts of the book Part 3 addresses various topics connecting the theory of chip firing to other areas of mathematics including the matrix tree theorem harmonic morphisms parking functions M matrices matroids the Tutte polynomial and simplicial homology The text is suitable for advanced undergraduates and beginning graduate students **Conversational Problem Solving Richard P. Stanley**, 2020-05-11 This book features mathematical problems and results that would be of interest to all mathematicians but especially undergraduates and even high school students who participate in mathematical competitions such as the International Math Olympiads and Putnam Competition The format is a dialogue between a professor and eight students in a summer problem solving camp and allows for a conversational approach to the problems as well as some mathematical humor and a few nonmathematical digressions. The problems have been selected for their entertainment value elegance trickiness and unexpectedness and have a wide range of difficulty from

trivial to horrendous They range over a wide variety of topics including combinatorics algebra probability geometry and set theory Most of the problems have not appeared before in a problem or expository format A Notes section at the end of the book gives historical information and references Matrix Inequalities for Iterative Systems Hanjo Taubig,2017-02-03 The book reviews inequalities for weighted entry sums of matrix powers Applications range from mathematics and CS to pure sciences It unifies and generalizes several results for products and powers of sesquilinear forms derived from powers of Hermitian positive semidefinite as well as nonnegative matrices It shows that some inequalities are valid only in specific cases How to translate the Hermitian matrix results into results for alternating powers of general rectangular matrices Inequalities that compare the powers of the row and column sums to the row and column sums of the matrix powers are refined for nonnegative matrices Lastly eigenvalue bounds and derive results for iterated kernels are improved

Algebraic Combinatorics Chris Godsil,1993-04-01 This book presents an introduction to some of the interactions between algebra and combinatorics It focuses on the characteristic and matchings polynomials of a graph and introduces the theory of polynomial spaces The book is intended for beginning graduate students in mathematics **Combinatorial Commutative Algebra** Ezra Miller, Bernd Sturmfels, 2004-12-21 Recent developments are covered Contains over 100 figures and 250 exercises Includes complete proofs Algebraic combinatorics Eiichi Bannai, Itō Tatsurō, 1984 **Combinatorics on Words** M. Lothaire, 2002-04-18 Comprehensive 2002 introduction to combinatorics on words for mathematicians and theoretical computer scientists Open Problems in Algebraic Combinatorics Christine Berkesch, Benjamin Brubaker, Gregg Musiker, Pavlo Pylyavskyy, Victor Reiner, 2024-08-21 In their preface the editors describe algebraic combinatorics as the area of combinatorics concerned with exact as opposed to approximate results and which puts emphasis on interaction with other areas of mathematics such as algebra topology geometry and physics It is a vibrant area which saw several major developments in recent years The goal of the 2022 conference Open Problems in Algebraic Combinatorics 2022 was to provide a forum for exchanging promising new directions and ideas The current volume includes contributions coming from the talks at the conference as well as a few other contributions written specifically for this volume The articles cover the majority of topics in algebraic combinatorics with the aim of presenting recent important research results and also important open problems and conjectures encountered in this research The editors hope that this book will facilitate the exchange of ideas in algebraic combinatorics **Algebraic Combinatorics** Christopher David Godsil, 2017 This graduate level text is distinguished both by the range of topics and the novelty of the material it treats more than half of the material in it has previously only appeared in research papers. The first half of this book introduces the characteristic and matchings polynomials of a graph It is instructive to consider these polynomials together because they have a number of properties in common The matchings polynomial has links with a number of problems in combinatorial enumeration particularly some of the current work on the combinatorics of orthogonal polynomials This connection is discussed at some

length and is also in part the stimulus for the inclusion of chapters on orthogonal polynomials and formal power series Many of the properties of orthogonal polynomials are derived from properties of characteristic polynomials. The second half of the book introduces the theory of polynomial spaces which provide easy access to a number of important results in design theory coding theory and the theory of association schemes This book should be of interest to second year graduate text reference in mathematics Provided by publisher Algebraic Combinatorics Peter Orlik, Volkmar Welker, 2007-07-23 This book is based on two series of lectures given at a summer school on algebraic combinatorics at the Sophus Lie Centre in Nordfjordeid Norway in June 2003 one by Peter Orlik on hyperplane arrangements and the other one by Volkmar Welker on free resolutions Both topics are essential parts of current research in a variety of mathematical fields and the present book makes these sophisticated tools available for graduate students **New Perspectives in Algebraic Combinatorics** Louis J. Billera, 1999-09-28 This text contains expository contributions by respected researchers on the connections between algebraic geometry topology commutative algebra representation theory and convex geometry Algebraic Combinatorics Hélène Barcelo, Gizem Karaali, Rosa Orellana, 2019-01-21 This edited volume features a curated selection of research in algebraic combinatorics that explores the boundaries of current knowledge in the field Focusing on topics experiencing broad interest and rapid growth invited contributors offer survey articles on representation theory symmetric functions invariant theory and the combinatorics of Young tableaux The volume also addresses subjects at the intersection of algebra combinatorics and geometry including the study of polytopes lattice points hyperplane arrangements crystal graphs and Grassmannians All surveys are written at an introductory level that emphasizes recent developments and open problems An interactive tutorial on Schubert Calculus emphasizes the geometric and topological aspects of the topic and is suitable for combinatorialists as well as geometrically minded researchers seeking to gain familiarity with relevant combinatorial tools Featured authors include prominent women in the field known for their exceptional writing of deep mathematics in an accessible manner Each article in this volume was reviewed independently by two referees The volume is suitable for graduate students and researchers interested in algebraic combinatorics **Algebraic Combinatorics and Quantum Groups** Naihuan Jing, 2003 Algebraic combinatorics has evolved into one of the most active areas of mathematics Its developments have become more interactive with not only its traditional field representation theory but also geometry mathematical physics and harmonic analysis This book presents articles from some of the key contributors in the area It covers Hecke algebras Hall algebras the Macdonald polynomial and its deviations and their relations with other fields

Combinatorics Nicholas Loehr,2023-01-09 Bijective proofs are some of the most elegant and powerful techniques in all of mathematics Suitable for readers without prior background in algebra or combinatorics the book presents an introduction to enumerative and algebraic combinatorics emphasizing bijective methods Algebraic Combinatorics I Eiichi Bannai, Tatsurō Itō,1984-01-21 Combinatorics and Graph Theory John Harris, Jeffry L. Hirst, Michael Mossinghoff, 2009-04-03 There are

certain rules that one must abide by in order to create a successful sequel Randy Meeks from the trailer to Scream 2 While we may not follow the precise rules that Mr Meeks had in mind for s cessful sequels we have made a number of changes to the text in this second edition In the new edition we continue to introduce new topics with concrete amples we provide complete proofs of almost every result and we preserve the book sfriendlystyle andlivelypresentation interspersingthetextwith occasional jokes and quotations The rst two chapters on graph theory and combinatorics remain largely independent and may be covered in either order Chapter 3 on in nite combinatorics and graphs may also be studied independently although many readers will want to investigate trees matchings and Ramsey theory for nite sets before exploring these topics for in nite sets in the third chapter Like the rst edition this text is aimed at upper division undergraduate students in mathematics though others will nd much of interest as well It assumes only familiarity with basic proof techniques and some experience with matrices and in nite series The second edition offersmany additionaltopics for use in the classroom or for independentstudy Chapter 1 includes new sectioncovering distance and related notions in graphs following an expanded introductory section This new section also introduces the adjacency matrix of a graph and describes its connection to important features of the graph

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