

# M301 Introduction to Combinatorial Theory

## homework sheet # 5

### Problem # 1

Show that  $1^2 + 3^2 + 5^2 + \cdots + (2n - 1)^2 = n^2(2n^2 - 1)$ .

### Problem # 2

We are looking for the number of ways of changing a dollar bill into coins (pennies, nickels, dimes, quarters, or a single dollar coin). Make up a suitable generating function for this. Which coefficient are we looking for? Evaluate that coefficient using Maple (using the command `expand`).

### Problem # 3

Determine whether the following sequences are graphical. If so, construct a graph with the appropriate degree sequence.

- (a) (4, 4, 3, 2, 1)
- (b) (3, 3, 2, 2, 2, 2, 1, 1)
- (c) (7, 7, 6, 5, 4, 4, 3, 2)
- (d) (7, 6, 6, 5, 4, 3, 2, 1)
- (e) (7, 4, 3, 3, 2, 2, 2, 1, 1, 1)

### Problem # 4

Show that the sequence  $(d_1, d_2, \dots, d_n)$  is graphical if and only if the sequence  $(n - d_1 - 1, n - d_2 - 1, \dots, n - d_n - 1)$  is graphical.

### Problem # 5

Verify that (3, 3, 2, 2, 1, 1, 1, 1) is the degree sequence of a tree. Construct three nonisomorphic trees with this degree sequences.

### Problem # 6

Construct two different 4-regular graphs on seven vertices. Then prove that they are nonisomorphic.

### Problem # 7

Suppose that an urn contains four balls with different colors. In how many ways can three balls be chosen (explain) ?

	order important	order unimportant
repetition allowed		
repetition not allowed		

# Introduction To Combinatorial Theory

**Martin J. Erickson**



## **Introduction To Combinatorial Theory:**

*Introduction to Combinatorial Theory* R. C. Bose, B. Manvel, 1984-03-19 A hands on constructive and computational approach to combinatorial topics with real life modern applications Provides a simple treatment of the subject Introduces topics such as counting designs and graphs The notation is standard and kept to a minimum Chapters end with historical remarks and suggestions for further reading

**Combinatorial Theory** Martin Aigner, 2012-12-06 This book offers a well organized easy to follow introduction to combinatorial theory with examples notes and exercises a very good introduction to combinatorics This book can warmly be recommended first of all to students interested in combinatorics Publicationes Mathematicae Debrecen

**Introduction to Combinatorics** Martin J. Erickson, 2011-10-24 This gradual systematic introduction to the main concepts of combinatorics is the ideal text for advanced undergraduate and early graduate courses in this subject Each of the book's three sections Existence Enumeration and Construction begins with a simply stated first principle which is then developed step by step until it leads to one of the three major achievements of combinatorics Van der Waerden's theorem on arithmetic progressions Polya's graph enumeration formula and Leech's 24 dimensional lattice Along the way Professor Martin J Erickson introduces fundamental results discusses interconnection and problem solving techniques and collects and disseminates open problems that raise new and innovative questions and observations His carefully chosen end of chapter exercises demonstrate the applicability of combinatorial methods to a wide variety of problems including many drawn from the William Lowell Putnam Mathematical Competition Many important combinatorial methods are revisited several times in the course of the text in exercises and examples as well as theorems and proofs This repetition enables students to build confidence and reinforce their understanding of complex material Mathematicians statisticians and computer scientists profit greatly from a solid foundation in combinatorics Introduction to Combinatorics builds that foundation in an orderly methodical and highly accessible manner

[Introduction to Combinatorics](#) A. B. Slomson, 1997-02-01 The growth in digital devices which require discrete formulation of problems has revitalized the role of combinatorics making it indispensable to computer science Furthermore the challenges of new technologies have led to its use in industrial processes communications systems electrical networks organic chemical identification coding theory economics and more With a unique approach Introduction to Combinatorics builds a foundation for problem solving in any of these fields Although combinatorics deals with finite collections of discrete objects and as such differs from continuous mathematics the two areas do interact The author therefore does not hesitate to use methods drawn from continuous mathematics and in fact shows readers the relevance of abstract pure mathematics to real world problems The author has structured his chapters around concrete problems and as he illustrates the solutions the underlying theory emerges His focus is on counting problems beginning with the very straightforward and ending with the complicated problem of counting the number of different graphs with a given number of vertices Its clear accessible style and detailed solutions to many of the

exercises from routine to challenging provided at the end of the book make *Introduction to Combinatorics* ideal for self study as well as for structured coursework      *Introduction to Combinatorics* ,1975      **Combinatorial Theory** Martin

Aigner,2012-12-06 It is now generally recognized that the field of combinatorics has over the past years evolved into a fully fledged branch of discrete mathematics whose potential with respect to computers and the natural sciences is only beginning to be realized Still two points seem to bother most authors The apparent difficulty in defining the scope of combinatorics and the fact that combinatorics seems to consist of a vast variety of more or less unrelated methods and results As to the scope of the field there appears to be a growing consensus that combinatorics should be divided into three large parts a Enumeration including generating functions inversion and calculus of finite differences b Order Theory including finite posets and lattices matroids and existence results such as Hall s and Ramsey s c Configurations including designs permutation groups and coding theory The present book covers most aspects of parts a and b but none of c The reasons for excluding c were twofold First there exist several older books on the subject such as Ryser 1 which I still think is the most seductive introduction to combinatorics Hall 2 and more recent ones such as Cameron Van Lint 1 on groups and designs and Blake Mullin 1 on coding theory whereas no comprehensive book exists on a and b      **Combinatorial Theory** Marshall Hall,2011-08-15 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      *Combinatorial Theory* Anne Penfold Street,1977

Combinatorics Russell Merris,2003-09-24 A mathematical gem freshly cleaned and polished This book is intended to be used as the text for a first course in combinatorics the text has been shaped by two goals namely to make complex mathematics accessible to students with a wide range of abilities interests and motivations and to create a pedagogical tool useful to the broad spectrum of instructors who bring a variety of perspectives and expectations to such a course Features retained from the first edition Lively and engaging writing style Timely and appropriate examples Numerous well chosen exercises Flexible modular format Optional sections and appendices Highlights of Second Edition enhancements Smoothed and polished exposition with a sharpened focus on key ideas Expanded discussion of linear codes New optional section on algorithms Greatly expanded hints and answers section Many new exercises and examples      **50 years of Combinatorics, Graph Theory, and Computing** Fan Chung,Ron Graham,Frederick Hoffman,Ronald C. Mullin,Leslie Hogben,Douglas B. West,2019-11-15 50 Years of Combinatorics Graph Theory and Computing advances research in discrete mathematics by providing current research surveys each written by experts in their subjects The book also celebrates outstanding mathematics from 50 years at the Southeastern International Conference on Combinatorics Graph Theory Graph Theory Combinatorial Matrix Theory Designs Geometry Packing and Covering Readers will discover the breadth and depth of the

presentations at the SEICCGTC as well as current research in combinatorics graph theory and computer science Features Commemorates 50 years of the Southeastern International Conference on Combinatorics Graph Theory Computing with research surveys Surveys highlight open questions to inspire further research Chapters are written by experts in their fields Extensive bibliographies are provided at the end of each chapter      **Combinatorial Theory** D. Jungnickel, K. Vedder, 2006-11-15      A Survey of Combinatorial Theory Jagdish N. Srivastava, 2014-05-12 A Survey of Combinatorial Theory covers the papers presented at the International Symposium on Combinatorial Mathematics and its Applications held at Colorado State University CSU Fort Collins Colorado on September 9 11 1971 The book focuses on the principles operations and approaches involved in combinatorial theory including the Bose Nelson sorting problem Golay code and Galois geometries The selection first ponders on classical and modern topics in finite geometrical structures balanced hypergraphs and applications to graph theory and strongly regular graph derived from the perfect ternary Golay code Discussions focus on perfect ternary Golay code finite projective and affine planes Galois geometries and other geometric structures The book then examines the characterization problems of combinatorial graph theory line minimal graphs with cyclic group circle geometry in higher dimensions and Cayley diagrams and regular complex polygons The text discusses combinatorial problems in finite Abelian groups dissection graphs of planar point sets combinatorial problems and results in fractional replication Bose Nelson sorting problem and some combinatorial aspects of coding theory The text also reviews the enumerative theory of planar maps balanced arrays and orthogonal arrays existence of resolvable block designs and combinatorial problems in communication networks The selection is a valuable source of information for mathematicians and researchers interested in the combinatorial theory      **Enumerative Combinatorics: Volume 1** Richard P. Stanley, 2002 This book is the first of a two volume basic introduction to enumerative combinatorics at a level suitable for graduate students and research mathematicians It concentrates on the theory and application of generating functions a fundamental tool in enumerative combinatorics The book covers those parts of enumerative combinatorics of greatest applicability to other areas of mathematics The four chapters are devoted to an introduction to enumeration suitable for advanced undergraduates sieve methods including the Principle of Inclusion Exclusion partially ordered sets and rational generating functions There are a large number of exercises almost all with solutions which greatly augment the text and provide entry into many areas not covered directly Graduate students and research mathematicians who wish to apply combinatorics to their work will find this an authoritative reference      *Notes on Introductory Combinatorics* George Polya, Robert E. Tarjan, Donald R. Woods, 2013-11-27 In the winter of 1978 Professor George Pólya and I jointly taught Stanford University's introductory combinatorics course This was a great opportunity for me as I had known of Professor Pólya since having read his classic book *How to Solve It* as a teenager Working with Pólya who was over ninety years old at the time was every bit as rewarding as I had hoped it would be His creativity intelligence warmth and generosity of spirit and wonderful gift for

teaching continue to be an inspiration to me Combinatorics is one of the branches of mathematics that play a crucial role in computer science since digital computers manipulate discrete finite objects Combinatorics impinges on computing in two ways First the properties of graphs and other combinatorial objects lead directly to algorithms for solving graph theoretic problems which have widespread application in non numerical as well as in numerical computing Second combinatorial methods provide many analytical tools that can be used for determining the worst case and expected performance of computer algorithms A knowledge of combinatorics will serve the computer scientist well Combinatorics can be classified into three types enumerative existential and constructive Enumerative combinatorics deals with the counting of combinatorial objects Existential combinatorics studies the existence or nonexistence of combinatorial configurations

Lessons in Play Michael H. Albert, Richard J. Nowakowski, David Wolfe, 2019-04-30 This second edition of *Lessons in Play* reorganizes the presentation of the popular original text in combinatorial game theory to make it even more widely accessible Starting with a focus on the essential concepts and applications it then moves on to more technical material Still written in a textbook style with supporting evidence and proofs the authors add many more exercises and examples and implement a two step approach for some aspects of the material involving an initial introduction examples and basic results to be followed later by more detail and abstract results Features Employs a widely accessible style to the explanation of combinatorial game theory Contains multiple case studies Expands further directions and applications of the field Includes a complete rewrite of CGSuite material

**The Probabilistic Method** Noga Alon, Joel H. Spencer, 2015-11-02 Praise for the Third Edition Researchers of any kind of extremal combinatorics or theoretical computer science will welcome the new edition of this book MAA Reviews Maintaining a standard of excellence that establishes *The Probabilistic Method* as the leading reference on probabilistic methods in combinatorics the Fourth Edition continues to feature a clear writing style illustrative examples and illuminating exercises The new edition includes numerous updates to reflect the most recent developments and advances in discrete mathematics and the connections to other areas in mathematics theoretical computer science and statistical physics Emphasizing the methodology and techniques that enable problem solving *The Probabilistic Method* Fourth Edition begins with a description of tools applied to probabilistic arguments including basic techniques that use expectation and variance as well as the more advanced applications of martingales and correlation inequalities The authors explore where probabilistic techniques have been applied successfully and also examine topical coverage such as discrepancy and random graphs circuit complexity computational geometry and derandomization of randomized algorithms Written by two well known authorities in the field the Fourth Edition features Additional exercises throughout with hints and solutions to select problems in an appendix to help readers obtain a deeper understanding of the best methods and techniques New coverage on topics such as the Local Lemma Six Standard Deviations result in Discrepancy Theory Property B and graph limits Updated sections to reflect major developments on the newest topics discussions of the hypergraph

container method and many new references and improved results The Probabilistic Method Fourth Edition is an ideal textbook for upper undergraduate and graduate level students majoring in mathematics computer science operations research and statistics The Fourth Edition is also an excellent reference for researchers and combinatorists who use probabilistic methods discrete mathematics and number theory Noga Alon PhD is Baumritter Professor of Mathematics and Computer Science at Tel Aviv University He is a member of the Israel National Academy of Sciences and Academia Europaea A coeditor of the journal Random Structures and Algorithms Dr Alon is the recipient of the Polya Prize The G del Prize The Israel Prize and the EMET Prize Joel H Spencer PhD is Professor of Mathematics and Computer Science at the Courant Institute of New York University He is the cofounder and coeditor of the journal Random Structures and Algorithms and is a Sloan Foundation Fellow Dr Spencer has written more than 200 published articles and is the coauthor of Ramsey Theory Second Edition also published by Wiley

*Cryptography, Information Theory, and Error-Correction* Aiden A. Bruen, Mario A. Forcinito, 2011-09-28 Discover the first unified treatment of today's most essential information technologies Compressing Encrypting and Encoding With identity theft cybercrime and digital file sharing proliferating in today's wired world providing safe and accurate information transfers has become a paramount concern The issues and problems raised in this endeavor are encompassed within three disciplines cryptography information theory and error correction As technology continues to develop these fields have converged at a practical level increasing the need for a unified treatment of these three cornerstones of the information age Stressing the interconnections of the disciplines Cryptography Information Theory and Error Correction offers a complete yet accessible account of the technologies shaping the 21st century This book contains the most up to date detailed and balanced treatment available on these subjects The authors draw on their experience both in the classroom and in industry giving the book's material and presentation a unique real world orientation With its reader friendly style and interdisciplinary emphasis Cryptography Information Theory and Error Correction serves as both an admirable teaching text and a tool for self learning The chapter structure allows for anyone with a high school mathematics education to gain a strong conceptual understanding and provides higher level students with more mathematically advanced topics The authors clearly map out paths through the book for readers of all levels to maximize their learning This book is suitable for courses in cryptography information theory or error correction as well as courses discussing all three areas Provides over 300 example problems with solutions Presents new and exciting algorithms adopted by industry Discusses potential applications in cell biology Details a new characterization of perfect secrecy Features in depth coverage of linear feedback shift registers LFSR a staple of modern computing Follows a layered approach to facilitate discussion with summaries followed by more detailed explanations Provides a new perspective on the RSA algorithm Cryptography Information Theory and Error Correction is an excellent in depth text for both graduate and undergraduate students of mathematics computer science and engineering It is also an authoritative overview for IT professionals statisticians

mathematicians computer scientists electrical engineers entrepreneurs and the generally curious      **Sensitivity Analysis in Linear Regression** Samprit Chatterjee, Ali S. Hadi, 2009-09-25 Treats linear regression diagnostics as a tool for application of linear regression models to real life data Presentation makes extensive use of examples to illustrate theory Assesses the effect of measurement errors on the estimated coefficients which is not accounted for in a standard least squares estimate but is important where regression coefficients are used to apportion effects due to different variables Also assesses qualitatively and numerically the robustness of the regression fit      Theory of Computational Complexity Ding-Zhu Du, Ker-I Ko, 2014-06-30 Praise for the First Edition complete up to date coverage of computational complexity theory the book promises to become the standard reference on computational complexity Zentralblatt MATH A thorough revision based on advances in the field of computational complexity and readers feedback the Second Edition of Theory of Computational Complexity presents updates to the principles and applications essential to understanding modern computational complexity theory The new edition continues to serve as a comprehensive resource on the use of software and computational approaches for solving algorithmic problems and the related difficulties that can be encountered Maintaining extensive and detailed coverage Theory of Computational Complexity Second Edition examines the theory and methods behind complexity theory such as computational models decision tree complexity circuit complexity and probabilistic complexity The Second Edition also features recent developments on areas such as NP completeness theory as well as A new combinatorial proof of the PCP theorem based on the notion of expander graphs a research area in the field of computer science Additional exercises at varying levels of difficulty to further test comprehension of the presented material End of chapter literature reviews that summarize each topic and offer additional sources for further study Theory of Computational Complexity Second Edition is an excellent textbook for courses on computational theory and complexity at the graduate level The book is also a useful reference for practitioners in the fields of computer science engineering and mathematics who utilize state of the art software and computational methods to conduct research      *Graph Theory* Russell Merris, 2011-09-20 A lively invitation to the flavor elegance and power of graph theory This mathematically rigorous introduction is tempered and enlivened by numerous illustrations revealing examples seductive applications and historical references An award winning teacher Russ Merris has crafted a book designed to attract and engage through its spirited exposition a rich assortment of well chosen exercises and a selection of topics that emphasizes the kinds of things that can be manipulated counted and pictured Intended neither to be a comprehensive overview nor an encyclopedic reference this focused treatment goes deeply enough into a sufficiently wide variety of topics to illustrate the flavor elegance and power of graph theory Another unique feature of the book is its user friendly modular format Following a basic foundation in Chapters 1 3 the remainder of the book is organized into four strands that can be explored independently of each other These strands center respectively around matching theory planar graphs and hamiltonian cycles topics involving chordal graphs and oriented graphs that naturally



emerge from recent developments in the theory of graphic sequences and an edge coloring strand that embraces both Ramsey theory and a self contained introduction to Pólya's enumeration of nonisomorphic graphs In the edge coloring strand the reader is presumed to be familiar with the disjoint cycle factorization of a permutation Otherwise all prerequisites for the book can be found in a standard sophomore course in linear algebra The independence of strands also makes Graph Theory an excellent resource for mathematicians who require access to specific topics without wanting to read an entire book on the subject

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