Review of the book

"Applied Combinatorics (Second Edition)"

Fred Roberts & Barry Tesman

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1 What the book is about

This 860 page gigantic book is about the amazing large fertile field of combinatorics with lots of modern applications. It comes 20 years after the first edition. The book has been substantially rewritten with more than 200 pages of new materials and many changes in the exercises. There are also many new examples to reflect the many new developments in computer science and biology since 1990.

Starting with the basic question "What is Combinatorics?", the authors stated the 3 main problems in the field:

1. Existence Problem (is there at least one arrangement of a particular kind)
2. The Counting Problem (how many such arrangements)
3. The Optimization Problem (which is the "best" arrangement)

All these 3 problems are dealt with superbly in this book, with many illustrative examples.

2 What the book is like

There are **4 parts** to this book:

Part1: Basic tools of Combinatorics
The usual suspects are there: basic counting rules, sum and product rule, permutations and combinations and their generations, basic introduction to algorithms (asymptotic analysis and NP-complete problems), culminating in the simple but powerful pigeonhole principle and its generalizations. All these are covered fairly exhaustively in 100 pages. There are many examples here together with many exercises. This is extremely helpful to any self motivated student, as many of us learn counting by studying many different types of examples and then testing our understanding by working through the exercises. (Brief answers are given to about 50%-70% of the exercises). One comment on their choice of examples. I am happy to report that the authors did give "non-trivial" examples (which is a rarity in many books). There are even examples by Paul Erdos.

There is also a large 110-page chapter on graph theory covering fundamental concepts, graph colorings (applications to scheduling etc), chromatic polynomials, trees (of course!) and their important applications in searching, sorting. There is also a short introduction to Ramsey numbers.

Relations are covered in a 50-page chapter, with basic concepts covered leading to the theory of stable marriages, partial orders, lattices and boolean algebras.

Part 2: The Counting Problem
Generating functions cover 70 pages, recurrence relations took up 60 pages, Principle of Inclusion and Exclusion (33 pages), culminating in the Polya theory of counting (50 pages). Once again there are many examples that will help the readers to understand.

Part 3: The Existence Problem
Combinatorial designs such as block designs, Latin squares, finite projective planes are covered in 70 pages. There is a 40 page-chapter on coding theory, with the use of block designs to find error-correcting codes. There is also a chapter on existence problems in graph theory, covering depth first search algorithms, one way street problem, Eulerian chains and graphs, (of course the famous Konisberg Bridge problem is here), the Chinese Postman Problem, the extremely important Hamiltonian chains and Paths - Traveling Salesman problem.

Part 4: Combinatorial Optimization
The different kinds of matchings and coverings are here, simple bipartite, perfect matchings and how to find them, maximum weight matching, stable matchings, and the number of stable matchings (50 pages). The authors also covered some optimization problems for graphs and networks: this includes the famous Kruskal algorithm, shortest route problem, Dijkstra's algorithm with application to scheduling problems, network flows including maximum flow problem and max-flow algorithm and its complexity, Menger's Theorem and matching, and minimum cost flow problems.

3 What I like about this book

Extensive up to date references, subject and author index are given to those who want to dwell deeper. Many important topics are covered and they are done in detail. This book is one of the rare ones that does the job really well. Plenty of interesting examples and exercises (with partial solutions to 50-70% of them). Many examples are really “applied”, as what the book's title suggest. The authors also covered many formulations of important problems. The proofs of theorems are carefully written out and not glossed over unlike many books of this nature.

The font size is quite large and the arguments are needly displayed.

4 Possible Improvements

Brief answers to every less trivial problem in the book will be helpful to those who want to check if they have done the problem correctly. Challenging problems should be marked with a *. More remarks at the end of each chapter to briefly say about new developments in that area (with references) would be very helpful. After all we all like to know the latest and best results. Coming up with a CD-Rom version (with animations) of the ideas behind the important algorithms (with colors) will be a bonus.

5 Would you recommend this book?

By now the reader should know that I strongly endorse this book. It is suitable for motivated math, computer science or engineering sophomores and even beginning graduate students. In fact bright high school students would love this book and if they are exposed early (through reading this book and being guided by their teachers), many of them might end up doing combinatorics for their careers!

I really love this book. It is a gem.

The reviewer is a researcher in infocomm security with specialty in math and cryptography. He was formerly a professor in math.