Combinatorics and Graph Theory. *By John M. Harris, Jeffry L. Hirst and Michael J. Mossinghoff.* Springer-Verlag, New York, 2000. ISBN 0-387-98736-3.

As implied by its appearance in Springer's *Undergraduate Texts in Mathematics* series, this textbook is an introduction to combinatorics aimed at undergraduates. More specifically, it presents graph theory, basic counting principles and selected infinite topics for an audience of students with a mathematical maturity typical of third or fourth year students.

The book begins with an introduction to graph theory — a defensible decision, though the reviewer has a preference in his own course for starting with counting (despite his overwhelming personal interest in graphs). Topics covered include trees, planarity, colorings, matchings and Ramsey theory. Here the selection of topics, the rigor of the presentation and proofs, the coverage given each topic, and the exercises might remind the reader of the excellent text by Wilson [1].

The second chapter presents many of the usual topics connected with basic counting principles, such as binomial coefficients, generating functions and Stirling numbers. What is different is that the usual buildup from addition and multiplication principles, through arrangements and distributions, seems to be almost nonexistent. After a scant three pages devoted to these initial topics there is a study of the properties of the binomial coefficients, and then follows inclusion-exclusion, Pólya's enumeration formula, Stirling and Bell numbers, concluding with a section on stable matching. For an introductory text, that states in the preface that no background in the subject is presumed, the lack of a healthy dose of simple counting problems seems a deficiency.

The first two chapters provide most of the bulk of the text and are followed by a section on related topics involving infinite sets. In the reviewer's semester-long course, there is always some time after counting and graph theory to devote to some optional topics, and the usual choice is to do a couple of weeks on designs, without the guidance of a text. For those interested in complementing the more standard topics with something different, this final chapter will fit the bill. However, as one would expect to be necessary for this audience, most of this section is devoted to preliminaries about infinite sets themselves, and not much is devoted to purely combinatorial questions.

The narrative and proofs are well written, and the authors are given to frequent uses of humor (especially in their dedications). Students should find this book as easy to read as any other good quality text written with them in mind. Each of the three chapters concludes with several paragraphs describing an excellent selection of more advanced texts or papers to consider for further study. The preface says that while the book is "intended for upper-division undergraduates," it should be accessible for lower-division students and "even talented high school students."

This last claim was tested by giving a copy of the book to a talented high school student to also review. "Talented" was defined here as a high school senior currently enrolled in a sophomore-level college linear algebra course, and planning next year to attend one of the most prestigious colleges in the country. He writes that the authors "...do a fine job of presenting the material in a way that an independent student could develop a comprehensive understanding of the material..." and they "...employ an almost conversational style that engages the reader and enhances the intuitive understanding of some very technical subjects."

There is a barely adequate selection of exercises, and most instructors might feel they want to simply assign *all* of them. About fifty subsections are followed by exercise sets. These usually contain five or more problems, but only once does there appear to be more than ten. Sometimes there are just two or three. Hopefully, the emphases of the problems selected, and their range of difficulty, will match the aims of most courses. The one suggestion for an improvement in this text would be a greater selection of problems so that instructors would have room to carefully choose their way to problem sets that reflect their particular courses.

The authors have expressed a desire to include applications, but most SIAM members will recognize that they are not industrial-strength. However, they are certainly appropriate within the aims of the text. So while graph theory finds applications in many fields, this is primarily a pure mathematics text, presenting graph theory and basic combinatorics as disciplines unto themselves.

Perhaps the reviewer's opinions are best summarized by the fact that he will be giving this book a close look for possible use the next time he teaches his upper-division introductory combinatorics course, especially if the first two chapters are sufficiently independent that they can be covered in the opposite order. However, the quick ramp-up of the chapter on counting problems and the paucity of homework exercises throughout might not be enough for the high quality of the exposition to overcome.

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References

[1] Wilson, Robin J. Introduction to Graph Theory. Fourth Edition. Addison Wesley Longman Limited, Essex, England, 1996.

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