

Contents

Preface	vii
Before you go	xv
1 Principles of Combinatorics	1
1.1 Typical counting questions and the product principle	2
1.2 Counting, overcounting, and the sum principle	15
1.3 Functions and the bijection principle	24
1.4 Relations and the equivalence principle	33
1.5 Existence and the pigeonhole principle	40
2 Distributions and Combinatorial Proofs	49
2.1 Counting functions	49
2.2 Counting subsets and multisets	59
2.3 Counting set partitions	67
2.4 Counting integer partitions	75
3 Algebraic Tools	83
3.1 Inclusion-exclusion	83
3.2 Mathematical induction	94
3.3 Using generating functions, part I	102
3.4 Using generating functions, part II	114
3.5 Techniques for solving recurrence relations	125
3.6 Solving linear recurrence relations	133
4 Famous Number Families	141
4.1 Binomial and multinomial coefficients	141
4.2 Fibonacci and Lucas numbers	152
4.3 Stirling numbers	162
4.4 Integer partition numbers	175
5 Counting Under Equivalence	187
5.1 Two examples	187
5.2 Permutation groups	189
5.3 Orbits and fixed point sets	200
5.4 Using the CFB theorem	206

5.5	Proving the CFB theorem	214
5.6	The cycle index and Pólya's theorem	217
6	Combinatorics on Graphs	225
6.1	Basic graph theory	225
6.2	Counting trees	238
6.3	Coloring and the chromatic polynomial	249
6.4	Ramsey theory	261
7	Designs and Codes	271
7.1	Construction methods for designs	271
7.2	The incidence matrix and symmetric designs	281
7.3	Fisher's inequality and Steiner systems	290
7.4	Perfect binary codes	297
7.5	Codes from designs, designs from codes	308
8	Partially Ordered Sets	317
8.1	Poset examples and vocabulary	317
8.2	Isomorphism and Sperner's theorem	327
8.3	Dilworth's theorem	332
8.4	Dimension	337
8.5	Möbius inversion, part I	345
8.6	Möbius inversion, part II	355
	Bibliography	365
	Hints and Answers to Selected Exercises	369
	List of Notation	385
	Index	387
	About the Author	391