

Contents

Chapter 1	Mathematical Programming: An Overview	1
1.1	An introduction to management science	2
1.2	Model classification	3
1.3	Formulation of some examples	7
1.4	A geometrical preview	16
1.5	A classification of mathematical programming models	28
Chapter 2	Solving Linear Programs	48
2.1	Simplex method—A preview	49
2.2	Reduction to canonical form	55
2.3	Simplex method—A full example	62
2.4	Formal procedure	67
2.5	Transition from Phase I to Phase II	73
2.6	Linear programs with bounded variables	78
Chapter 3	Sensitivity Analysis	91
3.1	An example for analysis	92
3.2	Shadow prices, reduced costs, and new activities	94
3.3	Variations in the objective coefficients	98
3.4	Variations in the righthand-side values	102
3.5	Alternative optimal solutions and shadow prices	107
3.6	The computer output—An example	109
3.7	Simultaneous variations within the ranges	111
3.8	Parametric programming	116
Chapter 4	Duality in Linear Programming	157
4.1	A preview of duality	157
4.2	Definition of the dual problem	162

4.3	Finding the dual in general	166
4.4	The fundamental duality properties	170
4.5	Complementary slackness	175
4.6	The dual simplex method	178
4.7	Primal-dual algorithms	181
4.8	Mathematical economics	183
4.9	Game theory	186
Chapter 5	Mathematical Programming in Practice	209
5.1	The decision-making process	209
5.2	Stages of formulation, solution, and implementation	215
5.3	The role of the computer	220
5.4	A simple example	229
Chapter 6	Integration of Strategic and Tactical Planning in the Aluminum Industry	269
6.1	The planning approach	269
6.2	The aluminum industry and smelter operations	270
6.3	Overview of the strategic planning model	272
6.4	Mathematical formulation of the strategic planning model	273
6.5	The tactical planning model	277
6.6	Mathematical formulation of the tactical planning model	283
6.7	Conclusion	287
Chapter 7	Planning the Mission and Composition of the U.S. Merchant Marine Fleet	291
7.1	Structure of the problem	292
7.2	The linear-programming model	295
7.3	Mathematical description of the model	296
7.4	Basic findings	298
7.5	Sensitivity analysis	301
	Summary and conclusions	307
Chapter 8	Network Models	310
8.1	The general network-flow problem	310
8.2	Special network models	313
8.3	The critical-path method	320
8.4	Capacitated production—A hidden network	324
8.5	Solving the transportation problem	326
8.6	Additional transportation considerations	336
8.7	The simplex method for networks	340
8.8	Solving the minimum-cost flow problem	345
Chapter 9	Integer Programming	366
9.1	Some integer-programming models	367
9.2	Formulating integer programs	373

9.3	A sample formulation	382
9.4	Some characteristics of integer programs—A sample problem	385
9.5	Branch-and-bound	387
9.6	Branch-and-bound for mixed-integer programs	396
9.7	Implicit enumeration	398
9.8	Cutting planes	402
Chapter 10	Design of a Naval Tender Job Shop	425
10.1	The problem description	426
10.2	The aggregate model	428
10.3	The detailed model	433
10.4	Interaction between the aggregate and detailed models	439
10.5	Implementing the model	442
10.6	Description of the data	447
Chapter 11	Dynamic Programming	453
11.1	An elementary example	453
11.2	Formalizing the dynamic-programming approach	461
11.3	Optimal capacity expansion	466
11.4	Discounting future returns	471
11.5	Shortest paths in a network	474
11.6	Continuous state-space problems	479
11.7	Dynamic programming under uncertainty	482
Chapter 12	Large-scale Systems	505
12.1	Large-scale problems	506
12.2	Decomposition method—A preview	512
12.3	Geometrical interpretation of decomposition	515
12.4	The decomposition algorithm	517
12.5	An example of the decomposition procedure	522
12.6	Economic interpretation of decomposition	527
12.7	Decomposition theory	530
12.8	Column generation	540
Chapter 13	Nonlinear Programming	561
13.1	Nonlinear programming problems	561
13.2	Local vs. global optimum	565
13.3	Convex and concave functions	568
13.4	Problem classification	572
13.5	Separable programming	573
13.6	Linear approximations of nonlinear programs	580
13.7	Quadratic programming	589
13.8	Unconstrained minimization and SUMT	593
13.9	One-dimensional optimization	602

Chapter 14	A System for Bank Portfolio Planning	625
14.1	Overview of portfolio planning	626
14.2	Formulation of the BONDS model	631
14.3	Problem size and structure	637
14.4	Managing a hypothetical portfolio	641
14.5	Evaluating the performance of the model	646
Appendix A	Vectors and Matrices	654
A.1	Vectors	654
A.2	Matrices	656
A.3	Linear programming in matrix form	659
A.4	The inverse of a matrix	661
A.5	Bases and representations	666
A.6	Extreme points of linear programs	671
Appendix B	Linear Programming in Matrix Form	675
B.1	A preview of the revised simplex method	675
B.2	Formalizing the approach	680
B.3	The revised simplex method—An example	684
B.4	Computer considerations and the product form	688
B.5	Sensitivity analysis revisited	690
B.6	Parametric programming	694
B.7	Duality theory in matrix form	699
B.8	Resolving degeneracy in the simplex method	703
Appendix C	A Labeling Algorithm for the Maximum-flow Network Problem	707
C.1	The maximal-flow problem	707
C.2	Maximal-flow algorithm—Formal statement	710
C.3	Sample solution	711
C.4	Verifying the algorithm—Max-flow/Min-cut	714
	References	R1
	Index	I1