1	Intr	duction to Operations Research	I		
	1.1	The Nature and History of Operations Research	1		
	1.2		3		
	1.3	The Modeling Process	9		
2	Line	ar Programming	3		
	2.1	Introduction to Linear Programming	3		
	2.2	Applications of Linear Programming	7		
		2.2.1 Production Planning	8		
		2.2.2 Diet Problems	20		
		2.2.3 Allocation Problems	26		
		2.2.4 Employee Scheduling	30		
		2.2.5 Dynamic Production – Inventory Models	33		
		2.2.6 Blending Problems	37		
		2.2	10		
	2.3	Graphical Representation and Solution	57		
		2.3.1 The Graphical Solution Method	57		
		2.3.2 Special Cases	66		
	2.4	1 ostopennane, 1 mary ses 1111111111111111111111111111111111	73		
		2 Graphical Scholling Lineary see	74		
		2.4.2 Economic Analysis of an Optimal Solution 8	34		
	2.5	Duality 9	96		
3	Mul	iobjective Programming)5		
	3.1	Vector Optimization			
	3.2	Solution Approaches to Vector Optimization Problems 11			
	3.3	Goal Programming			
4	Integer Programming				
	4.1	Definitions and Basic Concepts			
	4.2	Applications of Integer Programming			
		4.2.1 Cutting Stock Problems			
		4.2.2 Diet Problems Revisited			
		4.2.3 Land Use			



	4.2.4Modeling Fixed Charges1394.2.5Workload Balancing1424.3Solution Methods for Integer Programming Problems1444.3.1Cutting Plane Methods1444.3.2Branch-and-Bound Methods1494.3.3Heuristic Methods154
5	Network Models 175 5.1 Definitions and Conventions 175 5.2 Network Flow Problems 177 5.3 Shortest Path Problems 186 5.4 Spanning Tree Problems 194 5.5 Routing Problems 195 5.5.1 Arc Routing Problems 196
6	5.5.2 Node Routing Problems 204 Location Models 221 6.1 The Major Elements of Location Problems 221 6.2 Covering Problems 224 6.2.1 The Location Set Covering Problem 225 6.2.2 The Maximal Covering Location Problem 230 6.3 Center Problems 233 6.3.1 1-Center Problems 234 6.3.2 p-Center Problems 235 6.4 Median Problems 236 6.4.1 Minisum Problems in the Plane 237 6.4.2 Minisum Problems in Networks 241 6.5 Other Location Problems 245
7	Project Networks 257 7.1 The Critical Path Method 258 7.2 Project Acceleration 264 7.3 Project Planning with Resources 269 7.4 The PERT Method 272
8	Machine Scheduling2838.1 Basic Concepts of Machine Scheduling2848.2 Single Machine Scheduling Models2858.3 Parallel Machine Scheduling Models2898.4 Dedicated Machine Scheduling Models294
9	Decision Analysis3039.1 Introduction to Decision Analysis3039.2 Visualizations of Decision Problems3059.3 Decision Rules Under Uncertainty and Risk3089.4 Sensitivity Analyses3129.5 Decision Trees and the Value of Information3159.6 Utility Theory322

Contents xi

10	Multi	icriteria Decision Making	333
	10.1 10.2	The General Model and a Generic Solution Method	
11		ntory Models	
	11.1	Basic Concepts in Inventory Planning	
	11.2	The Economic Order Quantity (EOQ) Model	
	11.3	The Economic Order Quantity with Positive Lead Time	
	11.4	The Economic Order Quantity with Backorders	
	11.5	The Economic Order Quantity with Quantity Discounts	
	11.6	The Production Lot Size Model	
	11.7	The Economic Order Quantity with Stochastic Lead	
		Time Demand	359
		11.7.1 A Model That Optimizes the Reorder Point	360
		11.7.2 A Stochastic Model with Simultaneous Computation	
		of Order Quantity and Reorder Point	
	11.8	Extensions of the Basic Inventory Models	363
12	Stoch	nastic Processes and Markov Chains	369
	12.1	Basic Ideas and Concepts	
	12.2	Steady-State Solutions	
	12.3	Decision Making with Markov Chains	376
13	Waiti	ing Line Models	381
	13.1	Basic Queuing Models	
	13.2	Optimization in Queuing	389
14	Simu	llation	
	14.1	Introduction to Simulation	
	14.2	Random Numbers and Their Generation	
	14.3	Examples of Simulations	
		14.3.1 Simulation of a Waiting Line System	
		14.3.2 Simulation of an Inventory System	406
App	oendix	A: Heuristic Algorithms	417
Apj	pendix	B: Vectors and Matrices	425
App	oendix	C: Systems of Simultaneous Linear Equations	427
App	oendix	D: Probability and Statistics	431
Bib	liogra	phy	439
Ind	ex		441