

# Contents

<i>Preface</i>	vii
<i>Abbreviations</i>	ix
List of Algorithms	x
<b>1. Introduction</b>	1
<b>2. Some Basic Concepts</b>	13
2.1 Graphs, Paths and Chains	13
2.2 Matrices and Computer Representation of Graphs	21
2.3 Spanning Trees	29
2.4 Multi-stage Problems and Search Trees	35
Exercises	43
<b>3. Branch-and-bound Methods</b>	47
3.1 Concepts of B & B	47
3.2 Integer Linear Programming	57
Exercises	65
<b>4. Shortest Route Problems</b>	69
4.1 Shortest Path between Two Points	70
4.2 The Shortest Path Problem: General Case	78
4.3 Other Shortest Path Problems	84
Exercises	91
<b>5. Location Problems</b>	94
5.1 Single Facility Problems	95
5.2 Ordinary Location Problems	101
5.3 Location of Emergency Facilities	109
Exercises	118
<b>6. Project Networks</b>	121
6.1 Critical Path Methods	121
6.2 Alternative Approaches	129

6.3 Resource Allocation	133
Exercises	144
<b>7. The Travelling Salesman and Chinese Postman Problems</b>	148
7.1 Reduction-based Methods for Solving TSP	148
7.2 Other Approaches to TSP	157
7.3 The Chinese Postman Problem and Matching	163
Exercises	169
<b>8. Distribution Problems</b>	173
8.1 Single-depot Vehicle Routing Problems: TSP and Savings Based Methods	174
8.2 Angular Approaches to Vehicle Routing	185
8.3 Multi-depot Distribution Problems	190
Exercises	193
<b>9. Flows in Networks: Basic Model</b>	197
9.1 Complete Flows and Maximal Flows	197
9.2 Algorithms for Finding Maximal Flows	206
Exercises	212
<b>10. Network Flow: Extensions</b>	214
10.1 Various Extensions	214
10.2 Minimal Cost Flows	288
10.3 The Simplex Method Applied to Network Problems	240
Exercises	252
<b>11. Heuristic Methods</b>	255
11.1 Improvement Methods	256
11.2 Constructive Heuristic Methods	261
11.3 Problem Reduction: AND-OR Graphs	271
Exercises	279
<i>Appendix: Computational Complexity</i>	282
<i>References</i>	288
<i>Index</i>	298