

Table of Contents

Preface	9
Chapter 1 Mathematical Modelling: Aims and Philosophy	
1.1 Mathematics and Society	11
1.2 Mathematical Modelling – Its Role and Limitations	13
1.3 Case Study	15
1.4 Future Trends	18
1.5 Introduction to the Book	20
Chapter 2 Sequences and Series	
2.1 The Gnome Corporation Redemption Issue	21
2.2 Sequences; Arithmetic and Geometric Progressions	23
2.3 Solution to the Case Study	30
2.4 Case Studies	31
2.4.1 Nominal and Effective Interest Rates	31
2.4.2 Mr Smith’s Mortgage Problems	32
2.4.3 The Multiplier	34
2.4.4 The Size of the Firm	35
2.5 Problems	38
Chapter 3 Limits and Continuity	
3.1 The Case of the Bakewell Bean Promotion	41
3.2 The Theory of Functions of a Real Variable	41
3.3 Solution of the Bakewell Bean Promotion Problem	50
3.4 Case Studies	52
3.4.1 Production Costs	52
3.4.2 Continuously Accruing Interest: the Exponential and Logarithmic Functions	54
3.5 Problems	57

Chapter 4 Turning points and Changes: Models Based on the Differential Calculus

4.1	The Case of the Wonderbike Selling Price	61
4.2	Derivatives and Maxima and Minima of Functions of a Real Variables	63
4.3	Solution of the Wonderbike Selling Price Problem	68
4.4	Case Studies	70
4.4.1	The Economics of Production – Diminishing Returns	70
4.4.2	Drug Concentration in the Blood Stream.	73
4.4.3	The Kertz Leasing Company.	75
4.5	Problems	77

Chapter 5 Growth and Decay: Models Based on First Order Differential Equations

5.1	The Case of Cusp Containers	81
5.2	Theory of First Order Differential Equation	82
5.3	The Solution of the Cusp Containers Problem.	86
5.4	Case Studies	88
5.4.1	The National Debt and Gross National Product	88
5.4.2	Population Growth	90
5.4.3	Drug Distribution in the Body.	94
5.4.4	Dating Archaeological Samples	97
5.4.5	Response of Sales to Advertising	98
5.5	Problems	101

Chapter 6 Cycles and Oscillations: Models Based on Second Order Differential Equations

6.1	Control of the Economy by Government Spending	109
6.2	The Second Order Linear Differential Equation with Constant Coefficients	111
6.3	Solution of the Case Study	119
6.4	Case Studies	122
6.4.1	Pricing Policy for Optimum Inventory Level	122
6.4.2	Interacting Species	124
6.5	Problems	127

Chapter 7 Step by Step: Difference Equations

7.1	A National Economy Model for Jedesland	133
7.2	Difference Equations Theory.	135
7.2.1	Linear First Order.	135
7.2.2	Linear n^{th} Order.	138
7.2.3	Homogeneous Second Order.	139
7.2.4	Particular Solutions	142

7.3	Jedesland's National Economy	144
7.4	Case Studies	146
7.4.1	A Simple Population Model	146
7.4.2	The Cobweb Model of Supply and Demand	148
7.4.3	Prices and Inventory	151
7.5	Problems	153
Chapter 8 Vectors and Matrices: Linear models with Several Variables		
8.1	The Yummy Jam Company	159
8.2	Vector and Matrices - Preliminary Theory	159
8.3	Matrix Representation for the Yummy Jam Company	164
8.4	Input-output Models	166
8.5	Systems of Linear Equations	168
8.6	Input-output Solution	176
8.7	Case Studies	177
8.7.1	Coexistence of Bacteria	177
8.7.2	Production Explosion	178
8.7.3	Discrete Population Model with an Age Distribution	183
8.8	Problems	186
Chapter 9 Optimal Policy Decisions: Models based on Optimization Techniques		
9.1	The Precision Tool Company	193
9.2	Optimization Techniques	194
9.3	Solution of the Precision Tool Company's Problem	203
9.4	Case Studies	204
9.4.1	Stock Control with Shortages	204
9.4.2	Optimal Warehouse Area	207
9.4.3	Production Planning	208
9.4.4	Routeing Problem.	213
9.4.5	Resource Allocation	217
9.5	Problems	218
Chapter 10 Theory of Games		
10.1	The Prisoner's Dilemma	225
10.2	Rectangular Two-person Games	226
10.3	Case Studies	234
10.3.1	Competitive strategies	234
10.3.2	How to Beat General von Kluge.	236
10.3.3	Jamaican Fishermen	240
10.4	Problems	242

Chapter 11	An Explanation of Discontinuous Phenomena: Models Based on Catastrophe Theory	
11.1	The Case of the Tatopops Launch.	247
11.2	The Cusp Catastrophe	250
11.3	The Cusp Catastrophe Model for the Tatopops Launch.	252
11.4	Case Studies	254
11.4.1	‘Never Pat a Cowering Dog’	254
11.4.2	Catastrophes in Higher Dimensions	256
11.4.3	Mathematical Publication.	256
11.5	Problems	256
Appendix I	Number Systems	259
Appendix II	Integration	263
Appendix III	Partial Differentiation	267
Bibliography and References	269
Answers to Problems	271
Index	285