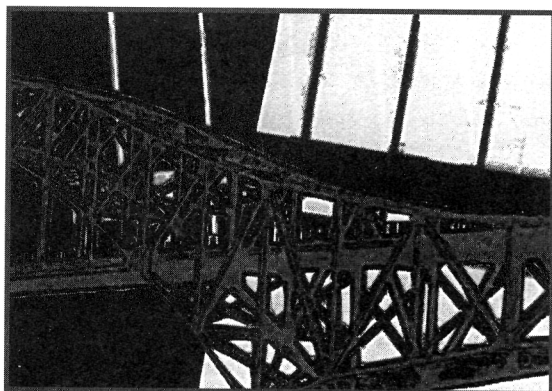


LABORATORIES IN MATHEMATICAL EXPERIMENTATION

A Bridge to Higher Mathematics



MOUNT HOLYOKE COLLEGE



Springer

CONTENTS

Preface	<i>vii</i>
Introduction	<i>xv</i>
1 Iteration of Linear Functions	1
1.1 Introduction	1
1.2 What is iteration?	2
1.3 The mathematical ideas	3
1.4 Questions to explore	7
1.5 Discussion	11
1.6 Bibliography	13
Computer programs	14
2 Cyclic Difference Sets	16
2.1 Introduction	16
2.2 Arithmetic modulo 15	17
2.3 Cyclic difference sets modulo m	19
2.4 Questions to explore	21
2.5 Discussion	24
Computer programs	25
3 The Euclidean Algorithm	30
3.1 Introduction	30
3.2 The algorithm	31
3.3 Questions and discussion	35
3.4 Linear Diophantine Equations	40
3.5 Additional topic	45
Computer programs	46

4	Prime Numbers	54
	4.1 Introduction	54
	4.2 Listing prime numbers	55
	4.3 Functions generating primes	60
	4.4 Distribution of primes	64
	4.5 Further reading	67
	Computer programs	67
5	The Coloring of Graphs	79
	5.1 Introduction	79
	5.2 Introduction to the mathematical ideas	81
	5.3 Questions to explore	90
	5.4 Bibliography	93
6	Randomized Response Surveys	94
	6.1 Introduction	94
	6.2 Asking sensitive questions	95
	6.3 Background	96
	6.4 Questions to explore	97
	Computer programs	112
7	Polyhedra	119
	7.1 Introduction	119
	7.2 Questions and discussion	120
	7.3 Additional topic	122
8	The p-adic Numbers	123
	8.1 Introduction	123
	8.2 Absolute values on \mathbf{Q}	125
	8.3 The real numbers	128
	8.4 The p -adic numbers	131
9	Parametric Curve Representation	142
	9.1 Introduction	142
	9.2 Symmetries and closed curves	143
	9.3 Questions to explore	149

9.4	Polar representation of curves	152
9.5	Additional ideas to explore	155
	Computer programs	155
10	Numerical Integration	159
10.1	Introduction	159
10.2	Standard numerical methods	160
10.3	Automating the standard methods	163
10.4	Questions to explore	166
10.5	Monte Carlo methods	169
10.6	Higher dimensions	172
	Computer programs	175
11	Sequences and Series	181
11.1	Introduction	181
11.2	The mathematical ideas	182
11.3	The harmonic series	185
11.4	The natural logarithm	191
11.5	Euler's constant	195
11.6	Additional exercises and questions	198
	Computer programs	200
12	Experiments in Periodicity	203
12.1	Introduction	203
12.2	Area accumulation using <code>CALCWIN</code>	205
12.3	A new type of function	212
12.4	Antiderivatives of periodic functions	214
12.5	Finding the periodic antiderivative	215
12.6	Further investigation	217
13	Iteration to Solve Equations	219
13.1	Introduction	219
13.2	Improving convergence	222
13.3	Questions to explore	223
	Computer programs	224

14	Iteration of Quadratic Functions	226
	14.1 Introduction	226
	14.2 Some theory	226
	14.3 Iterating $f(x) = ax(1 - x)$	227
	14.4 The Feigenbaum diagram	230
	14.5 Examining chaos	231
	14.6 The tent and sawtooth functions	234
	14.7 Conjugacy	235
	14.8 Iterating other functions	236
	14.9 Listening to chaos	236
	14.10 Bibliography	237
	Computer programs	237
15	Iterated Linear Maps in the Plane	243
	15.1 Introduction	243
	15.2 Multiplying matrices	244
	15.3 An example to start	247
	15.4 Questions to explore	252
	15.5 Discussion	253
	Computer programs	255
16	Euclidean Algorithm for Complex Integers	259
	16.1 Introduction	259
	16.2 Complex integers	260
	16.3 Questions and discussion	268
	Computer programs	271
	Index	275