## **Contents**

iii

XV

Preface

Installation

Book I User's Guide 1
A Guided Tour 3
Starting <i>Joy</i> 3
Graphing a Curve 4
Setting the Range of a Graph 6
Zooming In 7
Finding Coordinates 10
Displaying <i>Mathematica</i> 's Commands 11
Defining a Function and Using <i>Mathematica</i> 's Notation 12
Entering an Expression 14
Combining Graphs 15
Substituting Values and Using <i>Joy</i> 's Popup Menus 17
Putting Expressions in Decimal Form 20
Copying Output into <i>Joy</i> 20
Using Joy and Mathematica Interchangeably 22
Clearing Definitions or Values 24
Annotating Your Work 24
Canceling a Command in Progress 25
Keeping Track of Memory 26
Getting Help 26

2

3

4

Graphing a Sequence

Saving Your Work 28 Printing 30 Quitting *Joy* 32 Algebra 33 **Expanding Expressions** 33 Factoring Expressions 34 Repeating Operations 34 Collecting Terms Finding a Common Denominator 37 Simplifying Expressions Solving Equations Algebraically 38 Selecting Part of Mathematica's Output 39 Solving Equations Numerically 42 Estimating Roots of Polynomials Creating a List 43 Operating on a List Changing the Number of Decimal Places 44 Creating a Table 45 Plotting Points Animation 49 Graphing Two Curves 49 Graphing a Sequence of Curves 50 Animating the Graphs One-Variable Calculus 55 Differentiating 55 Antidifferentiating (the Indefinite Integral) 57 Integrating (the Definite Integral) 59 Integrating Numerically Simpson's Rule and Other Methods of Numerical Integration 61 Graphing Parametric Curves Graphing in Polar Coordinates **Graphing Implicit Functions** Listing the Values of a Sequence 66

Finding Taylor Polynomials 68
Graphing Taylor Polynomials 69
Newton's Method 70
Iterating a Function 74
Graphing the Iterations 75
Differential Equations 77
Slope Fields 77
Solving Differential Equations Algebraically 79
Solving Differential Equations Numerically 82
Multiporiable Calculus 80
Multivariable Calculus 89
Graphing a Surface in Three-Dimensional Space 89
Changing the Viewpoint of a Surface 90
Graphing Contours (Level Curves) 92
Graphing a Parametric Curve in Space 93
Graphing a Parametric Surface 94
Taking Partial Derivatives 95
Defining a Function of More Than One Variable 97
Graphing Gradients 98
Optimizing with Lagrange Multipliers 100
Multiple Integration 105
Matrices and Vectors 107
Creating a Matrix 107
Taking Linear Combinations of Matrices 108
Multiplying Matrices 109
Applying Elementary Row Operations 110
Taking a Determinant 111
Inverting a Matrix 112
Creating a Vector 113
Multiplying a Vector by a Matrix 115
Finding the Length of a Vector 115
Finding a Dot Product 117
Taking the Transpose of a Matrix 118
Row Reducing a Matrix 119
Raising a Matrix to a Power 121

5

6

8

Restoring Matrix Form

Extending Joy's Capabilities

Reexecuting Joy's Commands

**Entering Commands Directly** 

Extending Joy

Finding Eigenvalues and Eigenvectors

Changing the Arguments of a Command

Changing the Options of a Command

Using the Function Browser (2.2) to Find Options and Comme Further Help with Commands and Options 132 Using Joy with Packages 133 Using Joy with Notebooks Prepared by Others 135 Helpful Hints 137	ands 130
Appendix A: Troubleshooting 139	
Finding Files at Startup or when Running <i>Joy</i> 139	
Memory Problems and Remedies 141	
	of More Than On 74
Appendix B: Reference 151	
Joy's Menus 151	
Joy's Packages 199	
Using <i>Joy</i> with Different Versions of <i>Mathematica</i> 200	
Book II Applications and Explorations 203	
Part 1 Applications and Explorations in Functions and Grap	ohing 205
9 Completing the Square 207	113
10 Completing the Cube 210	
11 Fitting Cosines to Periodic Data 212	
12 Present Value, Geometric Series, and Lotteries 215	
13 Exponential and Power Functions 218	
14 Sines and the Piano 220	

123

128

125

126

127

Part 2 Application	ns and Explorations in Calculus 225
	inearity and Rates of Change 227
16 Optimiz	
17 Paramet	tric Curves: Gravity and Motion 232
	ndamental Theorem of Calculus and the Normal Curve 235
19 Numerio	cal Integration and Error Bounds 238
20 Newton	's Method for Estimating Roots 242
21 Iteration	and Fixed Points 244
Part 3 Further App	plications and Explorations in Calculus 249
	ring Series 251
23 Taylor I	Polynomials 254
24 Numerio	cal Estimation of Improper Integrals and the Normal Curve 256
	erizing Curves: Two Parameterizations of an Ellipse 259
26 Numerio	cal Integration and the Orbit of Halley's Comet 262
27 Directio	nal Derivatives, Gradients, and the Cobb-Douglas Function 266
28 Double	Integrals and Housing Prices 270
Part 4 Application	as and Explorations in Differential Equations 273
29 Least Sc	quares, Population, and the Logistic Equation 275
30 Numerio	cal Solution of Differential Equations: Designing a Waterslide 280
31 Sharks v	versus Fish: A Predator–Prey Model 285
Part 5 Application	as and Explorations in Matrices and Vectors 291
32 Row Re	duction and Solving Equations 293
33 Element	ary Matrices and Row Operations 295
34 Rotation	as and Reflections 298
35 Least Sc	quares and Matrices: Education and Employment 301
36 Markov	Chains and Market Share 304
37 Systems	of Linear Differential Equations: An Employment Model 307
Index 313	