

Contents

3466

Preface	xi
I Getting Started	1
1.1 Introduction to Mathematica	1
<i>A Note Regarding Different Versions of Mathematica</i>	2
1.2 Getting Started with Mathematica	2
<i>Preview</i>	8
1.3 Loading Packages	9
<i>A Word of Caution</i>	11
1.4 Getting Help from Mathematica	12
<i>Mathematica Help</i>	17
2 Mathematical Operations on Numbers, Expressions, and Functions	23
2.1 Numerical Calculations and Built-In Functions	23
<i>Numerical Calculations</i>	23
<i>Built-In Constants</i>	29
<i>Built-In Functions</i>	31
<i>A Word of Caution</i>	48
2.2 Expressions and Functions	49
<i>Basic Algebraic Operations on Expressions</i>	49
<i>Naming and Evaluating Expressions</i>	55
<i>Two Words of Caution</i>	57
<i>Defining and Evaluating Functions</i>	57
<i>Additional Ways to Evaluate Functions and Expressions</i>	64
<i>Composition of Functions</i>	66
<i>A Word of Caution</i>	69
2.3 Graphing Functions, Expressions, and Equations	70
<i>Graphing Functions of a Single Variable</i>	70
<i>Graphing Several Functions</i>	75
<i>Piecewise-Defined Functions</i>	78
<i>Graphs of Parametric Functions in Two Dimensions</i>	80
<i>Three-Dimensional Graphics</i>	85

Graphing Level Curves of Functions of Two Variables	92
Graphing Parametric Curves and Surfaces in Space.	97
A Word of Caution	106
2.4 Exact and Approximate Solutions of Equations	107
Exact Solutions of Equations	107
Numerical Approximation of Solutions of Equations	115
Application: Intersection Points of Graphs of Functions	120
3 Calculus	125
3.1 Computing Limits	125
Computing Limits	127
One-Sided Limits	133
A Word of Caution	134
3.2 Differential Calculus	135
Calculating Derivatives of Functions and Expressions	135
Tangent Lines	142
Locating Critical Points and Inflection Points	145
Using Derivatives to Graph Functions	148
Graphing Functions and Derivatives	154
Approximations with FindRoot	158
Application: Rolle's Theorem and the Mean-Value Theorem	161
Application: Graphing Functions and Tangent Lines	166
Application: Maxima and Minima	169
3.3 Implicit Differentiation	180
Computing Derivatives of Implicit Functions	180
Other Methods to Compute Derivatives of Implicit Functions	187
Other Methods to Graph Equations	188
3.4 Integral Calculus	189
Estimating Areas	189
Computing Definite and Indefinite Integrals	198
Approximating Definite Integrals	204
Application: Area Between Curves	206
Application: Arc Length.	212
Application: Volume of Solids of Revolution	213
Application: The Mean-Value Theorem for Integrals	218
A Word of Caution	219
3.5 Series	219
Introduction to Series	219
Determining the Interval of Convergence of a Power Series	227
Computing Power Series	231
Application: Approximating the Remainder.	237
Application: Series Solutions to Differential Equations	241
Other Series	247
3.6 Multivariable Calculus	249
Limits of Functions of Two Variables	249
Partial Differentiation	251

<i>Other Methods of Computing Derivatives</i>	255
<i>Application: Classifying Critical Points</i>	257
<i>Application: Tangent Planes</i>	264
<i>Application: The Method of Lagrange Multipliers</i>	266
Double Integrals	271
<i>Application: Volume</i>	275
Triple Integrals	282
Higher Order Integrals	284
4 Introduction to Lists and Tables	285
4.1 Defining Lists	285
<i>A Word of Caution</i>	292
4.2 Operations on Lists	293
<i>Extracting Elements of Lists</i>	293
<i>Graphing Lists of Points and Lists of Functions</i>	298
<i>Evaluation of Lists by Functions</i>	304
<i>Evaluation of Parts of Lists by Functions</i>	309
<i>Other List Operations</i>	310
<i>Alternative Way to Evaluate Lists by Functions</i>	312
4.3 Mathematics of Finance	313
<i>Application: Compound Interest</i>	313
<i>Application: Future Value</i>	315
<i>Application: Annuity Due</i>	317
<i>Application: Present Value</i>	319
<i>Application: Deferred Annuities</i>	320
<i>Application: Amortization</i>	322
<i>Application: Financial Planning</i>	327
4.4 Other Applications	337
<i>Application: Secant Lines, Tangent Lines, and Animations</i>	337
<i>Application: Approximating Lists with Functions</i>	344
<i>Application: Introduction to Fourier Series</i>	349
<i>Application: The One-Dimensional Heat Equation</i>	356
5 Nested Lists: Matrices and Vectors	361
5.1 Nested Lists	361
<i>Introduction to Matrices, Vectors, and Matrix Operations</i>	361
<i>Defining Nested Lists, Matrices and Vectors</i>	361
<i>Extracting Elements of Matrices</i>	370
<i>Basic Computations with Matrices and Vectors</i>	373
5.2 Linear Systems of Equations	379
<i>Calculating Solutions of Linear Systems of Equations</i>	379
<i>Gauss-Jordan Elimination</i>	384
5.3 Selected Topics from Linear Algebra	387
<i>Fundamental Subspaces Associated with Matrices</i>	387

<i>The Gram-Schmidt Process</i>	390
<i>Linear Transformations</i>	396
Application: Rotations	398
<i>Eigenvalues and Eigenvectors</i>	400
<i>Jordan Canonical Form</i>	405
<i>The QR Method</i>	409
5.4 Maxima and Minima Using Linear Programming	412
<i>The Standard Form of a Linear Programming Problem</i>	412
<i>The Dual Problem</i>	414
Application: A Transportation Problem	418
5.5 Vector Calculus	421
<i>Definitions and Notation</i>	421
Application: Green's theorem	430
Application: The Divergence theorem	432
Application: Stoke's theorem	434
6 Applications Related to Ordinary and Partial Differential Equations	439
6.1 First-Order Ordinary Differential Equations	440
<i>Separable Differential Equations</i>	440
<i>Homogeneous Differential Equations</i>	442
<i>Exact Equations</i>	446
<i>Linear Equations</i>	449
<i>Numerical Solutions of First-Order Initial-Value Problems</i>	453
Application: Population Growth and the Logistic Equation	456
Application: Newton's Law of Cooling	459
Application: Free-Falling Bodies	461
6.2 Higher Order Ordinary Differential Equations	465
<i>The Homogeneous Second-Order Equation with Constant Coefficients</i>	470
<i>Nonhomogeneous Equations with Constant Coefficients: Variation of Parameters</i>	475
<i>Cauchy-Euler Equations</i>	479
Application: Harmonic Motion	482
<i>Numerical Solutions of Higher Order Initial-Value Problems</i>	485
Application: The Simple Pendulum	486
6.3 Using the Laplace Transform to Solve Ordinary Differential Equations	491
<i>Definition of the Laplace Transform</i>	491
<i>Solving Ordinary Differential Equations with the Laplace Transform</i>	495
Application: The Convolution Theorem theorem	500
Application: The Dirac Delta Function	506
6.4 Systems of Ordinary Differential Equations	508
<i>Homogeneous Linear Systems with Constant Coefficients</i>	508
<i>Variation of Parameters</i>	514
<i>Nonlinear Systems, Linearization, and Classification of Equilibrium Points</i>	519
<i>Numerical Solutions of Initial-Value Problems Involving Systems of Ordinary</i>	
<i>Differential Equations</i>	520
Application: Predator-Prey Model	522
Application: The Double Pendulum	531

6.5	Some Partial Differential Equations.....	537
	<i>The One-Dimensional Wave Equation</i>	537
	<i>The Two-Dimensional Wave Equation</i>	542
	<i>Other Partial Differential Equations</i>	554
7	Some Graphics Packages	559
7.1	ComplexMap.....	560
7.2	ContourPlot3D	564
7.3	Graphics	566
	<i>Graphing in Polar Coordinates</i>	566
	<i>Creating Charts</i>	570
7.4	ImplicitPlot	572
7.5	MultipleListPlot and Graphics3D	576
7.6	PlotField and PlotField3D	577
7.7	Polyhedra and Shapes	582
	Selected References	591
	Index	595