

TABLE OF CONTENTS

PREFACE		xi
History		xiii
Chapter 1: BEFORE YOU BEGIN		1
Chapter 2: INTRODUCTION TO X(PLORE)		3
Starting X(PLORE)	2.1	3
Stopping X(PLORE)	2.1.1	6
Running the Demonstration Files	2.2	6
Calculating with Numbers and Variables	2.3	7
Infinite Precision Values	2.3.1	10
Graphing	2.4	11
Zoom and UnZoom	2.4.1	12
Three-Dimensional Graphs of Surfaces	2.5	14
Differentiation	2.6	14
Integration	2.7	15
Solving Equations	2.8	15
Matrices	2.9	17
User-Defined Functions	2.10	18
Chapter 3: CALCULATING WITH X(PLORE)		21
Entering Formulas into the Input Window	3.1	21
Cut and Paste	3.1.1	23
Saving and Loading ASCII Command Files	3.1.1.1	24
Mathematical Calculations	3.2	25
Numbers and Arithmetic	3.2.1	25
Algebraic Functions	3.2.2	28
Transcendental Functions	3.2.3	29
Miscellaneous Functions	3.2.4	30
Infinite Precision Values	3.2.5	32

Boolean Values and Inequalities	3.2.6	33
Logical Operators	3.2.6.1	35
Binary and Hexadecimal Numbers	3.2.7	36
Strings	3.3	38
Variables	3.4	39
Graphing	3.5	41
Cartesian Graphs	3.5.1	45
Polar Graphs	3.5.2	45
Parametric Graphs	3.5.3	47
Level Curves	3.5.4	48
Vector Fields and Trajectories	3.5.5	48
Adding Labels to Graphs	3.5.6	50
Lines and Rectangles, Marks and Points	3.5.7	52
Choosing Graph Colors and Line Styles	3.5.7.1	53
Filling Regions	3.5.7.2	55
Three-Dimensional Graphs	3.5.8	56
Three-Dimensional Graphs of Functions	3.5.8.1	56
Parametric Surfaces	3.5.8.2	58
Space Curves	3.5.8.3	60
Graphing Matrices	3.5.8.4	60
Differentiation	3.6	61
Higher-Order Derivatives	3.6.1	63
Partial Derivatives	3.6.2	63
Graphing Tangents	3.6.3	64
Integration	3.7	64
Improper Integrals	3.7.1	65
Graphing Integrals	3.7.2	69
Solving Equations	3.8	69
Solving Systems of Equations	3.8.1	71
Tables of Function Values	3.9	72
Sums and Products	3.10	73
Lists and Arrays	3.11	74
Creating and Modifying Lists	3.11.1	75
List Elements and Sublists	3.11.2	77
List Operations	3.11.3	78
Vector Operations	3.11.4	79
Lists and Statistics	3.11.5	79

Graphing Lists	3.11.6	80
Polynomials	3.11.7	82
Matrices	3.12	83
Creating Matrices	3.12.1	84
Matrix Operations	3.12.2	87
Eigenvectors and Eigenvalues	3.12.3	90
Defective Matrices	3.12.3.1	91
Singular Values, Condition Numbers, and the Pseudo-inverse	3.12.4	92
Statistical Operations with Matrices	3.12.5	93
Differentiating and Integrating Matrix Functions ...	3.12.6	95
User-Defined Functions	3.13	96
Functions with Derivatives and Integrals	3.13.1	98
Functions with Sums and Products; Taylor Polynomials and Fourier Series	3.13.2	98
Functions of Matrices and Lists	3.13.3	100
Defining Functions Implicitly	3.13.4	101
Differentiating Implicit Functions	3.13.5	102
Additional Features of X(PLORE)	3.14	104
Printing Formulas, Graphs and Results	3.14.1	105
Saving and Loading Command Files	3.14.2	108
Managing Directories	3.14.2.1	109
Protected Command Files	3.14.2.2	109
Saving and Loading Data Files	3.14.3	110
Loading ASCII Files	3.14.3.1	110
Saving and Loading Graphics Files	3.14.4	112
Text Screen Colors	3.14.5	113
Monochrome Screens and Portable Computers ...	3.14.5.1	113
Controlling Display Precision	3.14.6	114
Controlling Accuracy of Equation Solving and Integration	3.14.7	114
Monitoring Memory Usage	3.14.8	116
Shorthand Abbreviations and Greek Characters	13.14.9	118
Setting Start-up Options for X(PLORE)	3.14.10	119

Chapter 4: PROGRAMMING WITH X(PLORE)	121
How to Enter Subroutines	4.1 122
Functions and Procedures	4.2 123
User-defined Function Names as Parameters	4.2.1 125
Program Control Structures	4.3 126
Conditional Statements	4.3.1 127
For Loops	4.3.2 128
While and Repeat Loops	4.3.3 130
Special Programming Operations	4.4 131
Writing Output	4.4.1 132
Obtaining User Input	4.4.2 132
Graphics Programming	4.4.3 133
Displaying Messages and Getting User Input in Graphics Mode	4.4.3.1 137
Sound	4.4.4 137
Chapter 5: TECHNICAL NOTES	139
Variables: Free, Bound, and Local	5.1 139
Recursion	5.2 141
Recursive Subroutines	5.2.1 143
Recursive Variable Definitions	5.2.2 144
Recursive User-Defined Functions	5.2.3 144
Algorithms Used in X(PLORE)	5.3 146
Equation Solving	5.3.1 147
Factorials and the Gamma Function	5.3.2 149
Finding Roots of Polynomials	5.3.3 150
Matrix Algorithms	5.3.4 152
Chapter 6: APPLICATIONS	153
Interactive Applications	6.1 153
Integration and Equation Solving	6.1.1 153
Finding a Maximum	6.1.2 154
Finding Slopes and Graphing Tangents	6.1.3 156
Area between Curves	6.1.4 157
Study of an Ellipse	6.1.5 157
Computing Limits	6.1.6 160
The Cycloid	6.1.7 161
Graphing Hyperbolas and Their Asymptotes	6.1.8 162

Areas Bounded by Parametric Curves	6.1.9	162
Inflection Points	6.1.10	163
Improper Integrals	6.1.11	164
Graphing Tabular Data	6.1.12	167
Self-Intersection of Lissajous Curve	6.1.13	168
Midpoint, Trapezoidal, and Simpson's Approximations to Integrals	6.1.14	170
Self-Intersecting Polygons	6.1.15	173
Taylor Series	6.1.16	173
Parallel Curves	6.1.17	174
Cauchy Integrals	6.1.18	176
Tangent Lines to Polar Curves	6.1.19	177
The Hyperboloid of One Sheet as a Ruled Surface ...	6.1.20	178
Computing and Graphing Fourier Series	6.1.21	179
Financial Modeling	6.1.22	180
Discontinuous Functions	6.1.23	183
Analyzing Quadratic Forms	6.1.24	183
Markov Chains	6.1.25	184
Fitting Quadratic Curves	6.1.26	186
Finding Orthonormal Bases for Subspaces	6.1.27	187
Programming Applications	6.2	189
Illustrating Midpoint, Trapezoidal, and Simpson's Approximations to Integrals	6.2.1	189
Illustrating Secant and Newton's Methods for Solving Equations	6.2.2	192
Differential Equations	6.2.3	196
Interpolating Polynomials	6.2.4	199
Cubic Splines	6.2.5	202
Chaos Theory	6.2.6	204
Sierpinski Triangle	6.2.7	209
Turtle Geometry and the Koch Snowflake	6.2.8	210
Bar Graphs	6.2.9	214
Constructing Protractors	6.2.10	215
Gauss's Method for Approximating Elliptic Integrals .	6.2.11	217
Appendix 1: COMMANDS		221
Appendix 2: ERROR MESSAGES		231
Index		245