

# Contents

<b>Volume 0:</b>	<i>Axiom Jenks and Sutor</i>
<b>Volume 1:</b>	<i>Axiom Tutorial</i>
<b>Volume 2:</b>	<i>Axiom Users Guide</i>
<b>Volume 3:</b>	<i>Axiom Programmers Guide</i>
<b>Volume 4:</b>	<i>Axiom Developers Guide</i>
<b>Volume 5:</b>	<i>Axiom Interpreter</i>
<b>Volume 6:</b>	<i>Axiom Command</i>
<b>Volume 7:</b>	<i>Axiom Hyperdoc</i>
<b>Volume 7.1:</b>	<i>Axiom Hyperdoc Pages</i>
<b>Volume 8:</b>	<i>Axiom Graphics</i>
<b>Volume 9:</b>	<i>Axiom Compiler</i>
<b>Volume 10:</b>	<i>Axiom Algebra: Implementation</i>
<b>Volume 10.1:</b>	<i>Axiom Algebra: Theory</i>
<b>Volume 10.2:</b>	<i>Axiom Algebra: Categories</i>
<b>Volume 10.3:</b>	<i>Axiom Algebra: Domains</i>
<b>Volume 10.4:</b>	<i>Axiom Algebra: Packages</i>
<b>Volume 10.5:</b>	<i>Axiom Algebra: Numerics</i>
<b>Volume 11:</b>	<i>Axiom Browser</i>
<b>Volume 12:</b>	<i>Axiom Crystal</i>
<b>Bibliography:</b>	<i>Axiom Bibliography</i>

## Volume 0: Axiom Jenks and Sutor

0.1	Introduction to Axiom . . . . .	1
0.1.1	Symbolic Computation . . . . .	1
0.1.2	Numeric Computation . . . . .	2
0.1.3	Graphics . . . . .	3
0.1.4	HyperDoc . . . . .	3
0.1.5	Interactive Programming . . . . .	4
0.1.6	Data Structures . . . . .	6
0.1.7	Mathematical Structures . . . . .	7
0.1.8	Pattern Matching . . . . .	8
0.1.9	Polymorphic Algorithms . . . . .	8
0.1.10	Extensibility . . . . .	9
0.1.11	Types are Defined by Abstract Datatype Programs . . . . .	10
0.1.12	The Type of Basic Objects is a Domain or Subdomain . . . . .	11
0.1.13	Domains Have Types Called Categories . . . . .	11
0.1.14	Operations Can Refer To Abstract Types . . . . .	12
0.1.15	Categories Form Hierarchies . . . . .	12
0.1.16	Domains Belong to Categories by Assertion . . . . .	13
0.1.17	Packages Are Clusters of Polymorphic Operations . . . . .	13
0.1.18	The Interpreter Builds Domains Dynamically . . . . .	14
0.1.19	Axiom Code is Compiled . . . . .	14
0.1.20	Axiom is Extensible . . . . .	15
0.2	Using Axiom as a Pocket Calculator . . . . .	15
0.2.1	Basic Arithmetic . . . . .	16
0.2.2	Type Conversion . . . . .	17
0.2.3	Useful Functions . . . . .	19
0.3	Using Axiom as a Symbolic Calculator . . . . .	22
0.3.1	Expressions Involving Symbols . . . . .	22
0.3.2	Complex Numbers . . . . .	24
0.3.3	Number Representations . . . . .	25
0.3.4	Modular Arithmetic . . . . .	29
0.4	General Points about Axiom . . . . .	30
0.4.1	Computation Without Output . . . . .	30
0.4.2	Accessing Earlier Results . . . . .	31
0.4.3	Splitting Expressions Over Several Lines . . . . .	31
0.4.4	Comments and Descriptions . . . . .	31
0.4.5	Control of Result Types . . . . .	32
0.5	Data Structures in Axiom . . . . .	33
0.5.1	Lists . . . . .	33
0.5.2	Segmented Lists . . . . .	41
0.5.3	Streams . . . . .	42
0.5.4	Arrays, Vectors, Strings, and Bits . . . . .	45
0.5.5	Flexible Arrays . . . . .	47
0.6	Functions, Choices, and Loops . . . . .	50
0.6.1	Reading Code from a File . . . . .	50

0.6.2	Blocks . . . . .	50
0.6.3	Functions . . . . .	54
0.6.4	Choices . . . . .	57
0.6.5	Loops . . . . .	57
<b>1</b>	<b>An Overview of Axiom . . . . .</b>	<b>67</b>
1.1	Starting Up and Winding Down . . . . .	67
1.1.1	Clef . . . . .	68
1.2	Typographic Conventions . . . . .	69
1.3	The Axiom Language . . . . .	69
1.3.1	Arithmetic Expressions . . . . .	70
1.3.2	Previous Results . . . . .	70
1.3.3	Some Types . . . . .	71
1.3.4	Symbols, Variables, Assignments, and Declarations . . . . .	72
1.3.5	Conversion . . . . .	75
1.3.6	Calling Functions . . . . .	76
1.3.7	Some Predefined Macros . . . . .	77
1.3.8	Long Lines . . . . .	77
1.3.9	Comments . . . . .	78
1.4	Numbers . . . . .	78
1.5	Data Structures . . . . .	86
1.6	Expanding to Higher Dimensions . . . . .	93
1.7	Writing Your Own Functions . . . . .	95
1.8	Polynomials . . . . .	101
1.9	Limits . . . . .	102
1.10	Series . . . . .	104
1.11	Derivatives . . . . .	106
1.12	Integration . . . . .	109
1.13	Differential Equations . . . . .	113
1.14	Solution of Equations . . . . .	115
1.15	System Commands . . . . .	117
1.15.1	Undo . . . . .	118
1.16	Graphics . . . . .	121
<b>2</b>	<b>Using Types and Modes . . . . .</b>	<b>123</b>
2.1	The Basic Idea . . . . .	123
2.1.1	Domain Constructors . . . . .	125
2.2	Writing Types and Modes . . . . .	130
2.2.1	Types with No Arguments . . . . .	131
2.2.2	Types with One Argument . . . . .	132
2.2.3	Types with More Than One Argument . . . . .	133
2.2.4	Modes . . . . .	133
2.2.5	Abbreviations . . . . .	134
2.3	Declarations . . . . .	135
2.4	Records . . . . .	138
2.5	Unions . . . . .	142

2.5.1	Unions Without Selectors . . . . .	142
2.5.2	Unions With Selectors . . . . .	146
2.6	The “Any” Domain . . . . .	147
2.7	Conversion . . . . .	148
2.8	Subdomains Again . . . . .	151
2.9	Package Calling and Target Types . . . . .	155
2.10	Resolving Types . . . . .	158
2.11	Exposing Domains and Packages . . . . .	160
2.12	Commands for Snooping . . . . .	163
<b>3</b>	<b>Using HyperDoc</b>	<b>167</b>
3.1	Headings . . . . .	168
3.2	Key Definitions . . . . .	168
3.3	Scroll Bars . . . . .	169
3.4	Input Areas . . . . .	169
3.5	Radio Buttons and Toggles . . . . .	170
3.6	Search Strings . . . . .	170
3.6.1	Logical Searches . . . . .	171
3.7	Example Pages . . . . .	171
3.8	X Window Resources for HyperDoc . . . . .	172
<b>4</b>	<b>Input Files and Output Styles</b>	<b>175</b>
4.1	Input Files . . . . .	175
4.2	The .axiom.input File . . . . .	176
4.3	Common Features of Using Output Formats . . . . .	177
4.4	Monospace Two-Dimensional Mathematical Format . . . . .	178
4.5	TeX Format . . . . .	179
4.6	IBM Script Formula Format . . . . .	179
4.7	FORTTRAN Format . . . . .	180
<b>5</b>	<b>Overview of Interactive Language</b>	<b>185</b>
5.1	Immediate and Delayed Assignments . . . . .	185
5.2	Blocks . . . . .	189
5.3	if-then-else . . . . .	193
5.4	Loops . . . . .	195
5.4.1	Compiling vs. Interpreting Loops . . . . .	195
5.4.2	return in Loops . . . . .	195
5.4.3	break in Loops . . . . .	196
5.4.4	break vs. => in Loop Bodies . . . . .	198
5.4.5	More Examples of break . . . . .	198
5.4.6	iterate in Loops . . . . .	201
5.4.7	while Loops . . . . .	201
5.4.8	for Loops . . . . .	204
5.4.9	for i in n..m repeat . . . . .	205
5.4.10	for i in n..m by s repeat . . . . .	206
5.4.11	for i in n.. repeat . . . . .	207

5.4.12	for x in l repeat . . . . .	207
5.4.13	“Such that” Predicates . . . . .	209
5.4.14	Parallel Iteration . . . . .	209
5.4.15	Mixing Loop Modifiers . . . . .	212
5.5	Creating Lists and Streams with Iterators . . . . .	212
5.6	An Example: Streams of Primes . . . . .	216
<b>6</b>	<b>User-Defined Functions, Macros and Rules</b>	<b>221</b>
6.1	Functions vs. Macros . . . . .	221
6.2	Macros . . . . .	222
6.3	Introduction to Functions . . . . .	225
6.4	Declaring the Type of Functions . . . . .	227
6.5	One-Line Functions . . . . .	228
6.6	Declared vs. Undeclared Functions . . . . .	230
6.7	Functions vs. Operations . . . . .	232
6.8	Delayed Assignments vs. Functions with No Arguments . . . . .	233
6.9	How Axiom Determines What Function to Use . . . . .	234
6.10	Compiling vs. Interpreting . . . . .	237
6.11	Piece-Wise Function Definitions . . . . .	238
6.11.1	A Basic Example . . . . .	238
6.11.2	Picking Up the Pieces . . . . .	241
6.11.3	Predicates . . . . .	244
6.12	Caching Previously Computed Results . . . . .	246
6.13	Recurrence Relations . . . . .	248
6.14	Making Functions from Objects . . . . .	250
6.15	Functions Defined with Blocks . . . . .	254
6.16	Free and Local Variables . . . . .	258
6.17	Anonymous Functions . . . . .	264
6.17.1	Some Examples . . . . .	265
6.17.2	Declaring Anonymous Functions . . . . .	266
6.18	Example: A Database . . . . .	269
6.19	Example: A Famous Triangle . . . . .	271
6.20	Example: Testing for Palindromes . . . . .	274
6.21	Rules and Pattern Matching . . . . .	276
<b>7</b>	<b>Graphics</b>	<b>285</b>
7.1	Two-Dimensional Graphics . . . . .	286
7.1.1	Plotting Two-Dimensional Functions of One Variable . . . . .	286
7.1.2	Plotting Two-Dimensional Parametric Plane Curves . . . . .	287
7.1.3	Plotting Plane Algebraic Curves . . . . .	288
7.1.4	Two-Dimensional Options . . . . .	289
7.1.5	Color . . . . .	290
7.1.6	Palette . . . . .	291
7.1.7	Two-Dimensional Control-Panel . . . . .	292
7.1.8	Operations for Two-Dimensional Graphics . . . . .	294
7.1.9	Addendum: Building Two-Dimensional Graphs . . . . .	297

7.1.10	Addendum: Appending a Graph to a Viewport Window Containing a Graph . . . . .	304
7.2	Three-Dimensional Graphics . . . . .	305
7.2.1	Plotting Three-Dimensional Functions of Two Variables . . . . .	305
7.2.2	Plotting Three-Dimensional Parametric Space Curves . . . . .	306
7.2.3	Plotting Three-Dimensional Parametric Surfaces . . . . .	307
7.2.4	Axiom Images . . . . .	308
7.2.5	Three-Dimensional Options . . . . .	317
7.2.6	The makeObject Command . . . . .	320
7.2.7	Building Three-Dimensional Objects From Primitives . . . . .	321
7.2.8	Coordinate System Transformations . . . . .	326
7.2.9	Three-Dimensional Clipping . . . . .	328
7.2.10	Three-Dimensional Control-Panel . . . . .	329
7.2.11	Operations for Three-Dimensional Graphics . . . . .	333
7.2.12	Customization using .Xdefaults . . . . .	337
<b>8</b>	<b>Advanced Problem Solving</b>	<b>339</b>
8.1	Numeric Functions . . . . .	339
8.2	Polynomial Factorization . . . . .	349
8.2.1	Integer and Rational Number Coefficients . . . . .	349
8.2.2	Finite Field Coefficients . . . . .	350
8.2.3	Simple Algebraic Extension Field Coefficients . . . . .	350
8.2.4	Factoring Rational Functions . . . . .	352
8.3	Manipulating Symbolic Roots of a Polynomial . . . . .	353
8.3.1	Using a Single Root of a Polynomial . . . . .	353
8.3.2	Using All Roots of a Polynomial . . . . .	354
8.4	Computation of Eigenvalues and Eigenvectors . . . . .	356
8.5	Solution of Linear and Polynomial Equations . . . . .	360
8.5.1	Solution of Systems of Linear Equations . . . . .	360
8.5.2	Solution of a Single Polynomial Equation . . . . .	362
8.5.3	Solution of Systems of Polynomial Equations . . . . .	364
8.6	Limits . . . . .	367
8.7	Laplace Transforms . . . . .	371
8.8	Integration . . . . .	372
8.9	Working with Power Series . . . . .	376
8.9.1	Creation of Power Series . . . . .	376
8.9.2	Coefficients of Power Series . . . . .	379
8.9.3	Power Series Arithmetic . . . . .	380
8.9.4	Functions on Power Series . . . . .	381
8.9.5	Converting to Power Series . . . . .	384
8.9.6	Power Series from Formulas . . . . .	388
8.9.7	Substituting Numerical Values in Power Series . . . . .	391
8.9.8	Example: Bernoulli Polynomials and Sums of Powers . . . . .	392
8.10	Solution of Differential Equations . . . . .	396
8.10.1	Closed-Form Solutions of Linear Differential Equations . . . . .	396
8.10.2	Closed-Form Solutions of Non-Linear Differential Equations . . . . .	399

8.10.3	Power Series Solutions of Differential Equations . . . . .	404
8.11	Finite Fields . . . . .	406
8.11.1	Modular Arithmetic and Prime Fields . . . . .	406
8.11.2	Extensions of Finite Fields . . . . .	410
8.11.3	Irreducible Modulus Polynomial Representations . . . . .	412
8.11.4	Cyclic Group Representations . . . . .	415
8.11.5	Normal Basis Representations . . . . .	418
8.11.6	Conversion Operations for Finite Fields . . . . .	420
8.11.7	Utility Operations for Finite Fields . . . . .	424
8.12	Primary Decomposition of Ideals . . . . .	431
8.13	Computation of Galois Groups . . . . .	434
8.14	Non-Associative Algebras and Modelling Genetic Laws . . . . .	443
<b>9</b>	<b>Some Examples of Domains and Packages</b>	<b>449</b>
9.1	ApplicationProgramInterface . . . . .	449
9.2	ArrayStack . . . . .	450
9.3	AssociationList . . . . .	454
9.4	BalancedBinaryTree . . . . .	457
9.5	BasicOperator . . . . .	459
9.6	BinaryExpansion . . . . .	463
9.7	BinarySearchTree . . . . .	465
9.8	CardinalNumber . . . . .	467
9.9	CartesianTensor . . . . .	471
9.10	Character . . . . .	483
9.11	CharacterClass . . . . .	485
9.12	CliffordAlgebra . . . . .	488
9.12.1	The Complex Numbers as a Clifford Algebra . . . . .	488
9.12.2	The Quaternion Numbers as a Clifford Algebra . . . . .	490
9.12.3	The Exterior Algebra on a Three Space . . . . .	492
9.12.4	The Dirac Spin Algebra . . . . .	494
9.13	Complex . . . . .	496
9.14	ContinuedFraction . . . . .	499
9.15	CycleIndicators . . . . .	505
9.16	DeRhamComplex . . . . .	516
9.17	DecimalExpansion . . . . .	523
9.18	Dequeue . . . . .	525
9.19	DistributedMultivariatePolynomial . . . . .	531
9.20	DoubleFloat . . . . .	534
9.21	EqTable . . . . .	536
9.22	Equation . . . . .	537
9.23	EuclideanGroebnerBasisPackage . . . . .	539
9.24	Exit . . . . .	540
9.25	Expression . . . . .	541
9.26	Factored . . . . .	547
9.26.1	Decomposing Factored Objects . . . . .	547
9.26.2	Expanding Factored Objects . . . . .	549

9.26.3	Arithmetic with Factored Objects . . . . .	550
9.26.4	Creating New Factored Objects . . . . .	552
9.26.5	Factored Objects with Variables . . . . .	553
9.27	FactoredFunctions2 . . . . .	554
9.28	File . . . . .	556
9.29	FileName . . . . .	558
9.30	FlexibleArray . . . . .	562
9.31	Float . . . . .	565
9.31.1	Introduction to Float . . . . .	565
9.31.2	Conversion Functions . . . . .	566
9.31.3	Output Functions . . . . .	569
9.31.4	An Example: Determinant of a Hilbert Matrix . . . . .	571
9.32	Fraction . . . . .	573
9.33	FullPartialFractionExpansion . . . . .	576
9.34	GeneralDistributedMultivariatePolynomial . . . . .	581
9.35	GeneralSparseTable . . . . .	583
9.36	GroebnerFactorizationPackage . . . . .	584
9.37	GroebnerPackage . . . . .	586
9.38	Heap . . . . .	587
9.39	HexadecimalExpansion . . . . .	589
9.40	HomogeneousDistributedMultivariatePolynomial . . . . .	591
9.41	Integer . . . . .	593
9.41.1	Basic Functions . . . . .	593
9.41.2	Primes and Factorization . . . . .	599
9.41.3	Some Number Theoretic Functions . . . . .	600
9.42	IntegerLinearDependence . . . . .	602
9.43	IntegerNumberTheoryFunctions . . . . .	604
9.44	Kernel . . . . .	609
9.45	KeyedAccessFile . . . . .	613
9.46	LexTriangularPackage . . . . .	617
9.47	LazardSetSolvingPackage . . . . .	644
9.48	Library . . . . .	654
9.49	LieExponentials . . . . .	656
9.50	LiePolynomial . . . . .	658
9.51	LinearOrdinaryDifferentialOperator . . . . .	663
9.51.1	Differential Operators with Series Coefficients . . . . .	663
9.52	LinearOrdinaryDifferentialOperator1 . . . . .	668
9.52.1	Differential Operators with Rational Function Coefficients . . . . .	668
9.53	LinearOrdinaryDifferentialOperator2 . . . . .	673
9.53.1	Differential Operators with Constant Coefficients . . . . .	673
9.53.2	Differential Operators with Matrix Coefficients Operating on Vectors . . . . .	675
9.54	List . . . . .	679
9.54.1	Creating Lists . . . . .	679
9.54.2	Accessing List Elements . . . . .	680
9.54.3	Changing List Elements . . . . .	683
9.54.4	Other Functions . . . . .	684



9.54.5 Dot, Dot . . . . .	686
9.55 LyndonWord . . . . .	686
9.56 Magma . . . . .	690
9.57 MakeFunction . . . . .	694
9.58 MappingPackage1 . . . . .	696
9.59 Matrix . . . . .	702
9.59.1 Creating Matrices . . . . .	702
9.59.2 Operations on Matrices . . . . .	707
9.60 Multiset . . . . .	710
9.61 MultivariatePolynomial . . . . .	713
9.62 None . . . . .	716
9.63 NottinghamGroup . . . . .	716
9.64 Octonion . . . . .	717
9.65 OneDimensionalArray . . . . .	720
9.66 Operator . . . . .	722
9.67 OrderedVariableList . . . . .	726
9.68 OrderlyDifferentialPolynomial . . . . .	728
9.69 PartialFraction . . . . .	735
9.70 Permanent . . . . .	738
9.71 Permutation . . . . .	739
9.72 Polynomial . . . . .	740
9.73 Quaternion . . . . .	750
9.74 Queue . . . . .	752
9.75 RadixExpansion . . . . .	755
9.76 RealClosure . . . . .	758
9.77 RealSolvePackage . . . . .	772
9.78 RegularTriangularSet . . . . .	773
9.79 RomanNumeral . . . . .	789
9.80 Segment . . . . .	791
9.81 SegmentBinding . . . . .	794
9.82 Set . . . . .	795
9.83 SingleInteger . . . . .	799
9.84 SparseTable . . . . .	801
9.85 SquareMatrix . . . . .	803
9.86 SquareFreeRegularTriangularSet . . . . .	804
9.87 Stack . . . . .	810
9.88 Stream . . . . .	813
9.89 String . . . . .	815
9.90 StringTable . . . . .	822
9.91 Symbol . . . . .	822
9.92 Table . . . . .	827
9.93 TextFile . . . . .	831
9.94 TwoDimensionalArray . . . . .	833
9.95 TwoDimensionalViewport . . . . .	838
9.96 UnivariatePolynomial . . . . .	845
9.97 UnivariateSkewPolynomial . . . . .	853

9.97.1 A second example . . . . .	855
9.97.2 A third example . . . . .	856
9.97.3 A fourth example . . . . .	857
9.98 UniversalSegment . . . . .	858
9.99 Vector . . . . .	860
9.100 Void . . . . .	863
9.101 WuWenTsunTriangularSet . . . . .	864
9.102 XPBWPolynomial . . . . .	868
9.103 XPolynomial . . . . .	875
9.104 XPolynomialRing . . . . .	878
9.105 ZeroDimensionalSolvePackage . . . . .	882
<b>10 Interactive Programming</b>	<b>905</b>
10.1 Drawing Ribbons Interactively . . . . .	905
10.2 A Ribbon Program . . . . .	907
10.3 Coloring and Positioning Ribbons . . . . .	908
10.4 Points, Lines, and Curves . . . . .	909
10.5 A Bouquet of Arrows . . . . .	911
10.6 Diversion: When Things Go Wrong . . . . .	912
10.7 Drawing Complex Vector Fields . . . . .	912
10.8 Drawing Complex Functions . . . . .	914
10.9 Functions Producing Functions . . . . .	915
10.10 Automatic Newton Iteration Formulas . . . . .	916
<b>11 Packages</b>	<b>921</b>
11.1 Names, Abbreviations, and File Structure . . . . .	921
11.2 Syntax . . . . .	922
11.3 Abstract Datatypes . . . . .	923
11.4 Capsules . . . . .	923
11.5 Input Files vs. Packages . . . . .	924
11.6 Compiling Packages . . . . .	925
11.7 Parameters . . . . .	926
11.8 Conditionals . . . . .	927
11.9 Testing . . . . .	929
11.10 How Packages Work . . . . .	931
<b>12 Categories</b>	<b>933</b>
12.1 Definitions . . . . .	934
12.2 Exports . . . . .	935
12.3 Documentation . . . . .	935
12.4 Hierarchies . . . . .	936
12.5 Membership . . . . .	937
12.6 Defaults . . . . .	937
12.7 Axioms . . . . .	938
12.8 Correctness . . . . .	939
12.9 Attributes . . . . .	940

12.10Parameters . . . . .	941
12.11Conditionals . . . . .	941
12.12Anonymous Categories . . . . .	942
<b>13 Domains</b>	<b>945</b>
13.1 Domains vs. Packages . . . . .	945
13.2 Definitions . . . . .	946
13.3 Category Assertions . . . . .	946
13.4 A Demo . . . . .	948
13.5 Browse . . . . .	949
13.6 Representation . . . . .	949
13.7 Multiple Representations . . . . .	950
13.8 Add Domain . . . . .	951
13.9 Defaults . . . . .	951
13.10Origins . . . . .	952
13.11Short Forms . . . . .	952
13.12Example 1: Clifford Algebra . . . . .	953
13.13Example 2: Building A Query Facility . . . . .	955
13.13.1 A Little Query Language . . . . .	955
13.13.2 The Database Constructor . . . . .	956
13.13.3 Query Equations . . . . .	958
13.13.4 DataLists . . . . .	958
13.13.5 Index Cards . . . . .	959
13.13.6 Creating a Database . . . . .	959
13.13.7 Putting It All Together . . . . .	960
13.13.8 Example Queries . . . . .	960
<b>14 Browse</b>	<b>963</b>
14.1 The Front Page: Searching the Library . . . . .	963
14.2 The Constructor Page . . . . .	967
14.2.1 Constructor Page Buttons . . . . .	969
14.2.2 Cross Reference . . . . .	974
14.2.3 Views Of Constructors . . . . .	977
14.2.4 Giving Parameters to Constructors . . . . .	978
14.3 Miscellaneous Features of Browse . . . . .	979
14.3.1 The Description Page for Operations . . . . .	979
14.3.2 Views of Operations . . . . .	981
14.3.3 Capitalization Convention . . . . .	984
<b>15 What's New in Axiom Version 2.0</b>	<b>985</b>
15.1 Important Things to Read First . . . . .	985
15.2 The NAG Library Link . . . . .	985
15.2.1 Interpreting NAG Documentation . . . . .	986
15.2.2 Using the Link . . . . .	987
15.2.3 Providing values for Argument Subprograms . . . . .	989
15.2.4 General Fortran-generation utilities in Axiom . . . . .	990

15.2.5	Some technical information . . . . .	998
15.3	Interactive Front-end and Language . . . . .	999
15.4	Library . . . . .	1000
15.5	HyperTex . . . . .	1001
15.6	Documentation . . . . .	1002
<b>A</b>	<b>Axiom System Commands</b>	<b>1003</b>
A.1	Introduction . . . . .	1003
A.2	)abbreviation . . . . .	1004
A.3	)boot . . . . .	1006
A.4	)browse . . . . .	1006
A.5	)cd . . . . .	1007
A.6	)close . . . . .	1007
A.7	)clear . . . . .	1008
A.8	)compile . . . . .	1009
A.9	)display . . . . .	1012
A.10	)edit . . . . .	1013
A.11	)fin . . . . .	1014
A.12	)frame . . . . .	1014
A.13	)help . . . . .	1016
A.14	)history . . . . .	1016
A.15	)include . . . . .	1019
A.16	)library . . . . .	1019
A.17	)lisp . . . . .	1020
A.18	)load . . . . .	1020
A.19	)trace . . . . .	1021
A.20	)pquit . . . . .	1021
A.21	)quit . . . . .	1022
A.22	)read . . . . .	1022
A.23	)set . . . . .	1023
A.24	)show . . . . .	1024
A.25	)spool . . . . .	1025
A.26	)synonym . . . . .	1025
A.27	)system . . . . .	1026
A.28	)trace . . . . .	1027
A.29	)undo . . . . .	1031
A.30	)what . . . . .	1032
<b>B</b>	<b>Categories</b>	<b>1035</b>
<b>C</b>	<b>Domains</b>	<b>1047</b>
<b>D</b>	<b>Packages</b>	<b>1079</b>
<b>E</b>	<b>Operations</b>	<b>1095</b>

<b>F</b>	<b>Programs for AXIOM Images</b>	<b>1199</b>
F.1	images1.input . . . . .	1199
F.2	images2.input . . . . .	1200
F.3	images3.input . . . . .	1200
F.4	images5.input . . . . .	1200
F.5	images6.input . . . . .	1202
F.6	images7.input . . . . .	1202
F.7	images8.input . . . . .	1203
F.8	conformal.input . . . . .	1203
F.9	tknot.input . . . . .	1206
F.10	ntube.input . . . . .	1207
F.11	dhtri.input . . . . .	1208
F.12	tetra.input . . . . .	1209
F.13	antoine.input . . . . .	1211
F.14	scherk.input . . . . .	1212
<b>G</b>	<b>Glossary</b>	<b>1215</b>
<b>H</b>	<b>License</b>	<b>1237</b>

## Volume 1: Axiom Tutorial

<b>1</b>	<b>Axiom Features</b>	<b>1</b>
1.1	Introduction to Axiom . . . . .	1
1.1.1	Symbolic Computation . . . . .	1
1.1.2	Numeric Computation . . . . .	2
1.1.3	Mathematical Structures . . . . .	3
1.1.4	HyperDoc . . . . .	4
1.1.5	Interactive Programming . . . . .	5
1.1.6	Graphics . . . . .	6
1.1.7	Data Structures . . . . .	7
1.1.8	Pattern Matching . . . . .	8
1.1.9	Polymorphic Algorithms . . . . .	9
1.1.10	Extensibility . . . . .	10
1.1.11	Open Source . . . . .	11
<b>2</b>	<b>Ten Fundamental Ideas</b>	<b>13</b>
2.0.12	Types are Defined by Abstract Datatype Programs . . . . .	14
2.0.13	The Type of Basic Objects is a Domain or Subdomain . . . . .	14
2.0.14	Domains Have Types Called Categories . . . . .	15
2.0.15	Operations Can Refer To Abstract Types . . . . .	15
2.0.16	Categories Form Hierarchies . . . . .	15
2.0.17	Domains Belong to Categories by Assertion . . . . .	16
2.0.18	Packages Are Clusters of Polymorphic Operations . . . . .	17
2.0.19	The Interpreter Builds Domains Dynamically . . . . .	17
2.0.20	Axiom Code is Compiled . . . . .	18
2.0.21	Axiom is Extensible . . . . .	18
<b>3</b>	<b>Starting Axiom</b>	<b>21</b>
3.1	Starting Up and Winding Down . . . . .	21
3.1.1	Clef . . . . .	22
3.1.2	Typographic Conventions . . . . .	22
3.2	The Axiom Language . . . . .	23
3.2.1	Arithmetic Expressions . . . . .	23
3.2.2	Previous Results . . . . .	24
3.2.3	Some Types . . . . .	25
3.2.4	Symbols, Variables, Assignments, and Declarations . . . . .	26
3.2.5	Conversion . . . . .	28
3.2.6	Calling Functions . . . . .	29
3.2.7	Some Predefined Macros . . . . .	30
3.2.8	Long Lines . . . . .	31
3.2.9	Comments . . . . .	31
3.3	Using Axiom as a Pocket Calculator . . . . .	31
3.3.1	Basic Arithmetic . . . . .	31
3.3.2	Type Conversion . . . . .	33

3.3.3	Useful Functions . . . . .	35
3.4	Using Axiom as a Symbolic Calculator . . . . .	38
3.4.1	Expressions Involving Symbols . . . . .	38
3.4.2	Complex Numbers . . . . .	39
3.4.3	Number Representations . . . . .	41
3.4.4	Modular Arithmetic . . . . .	45
3.5	General Points about Axiom . . . . .	46
3.5.1	Computation Without Output . . . . .	46
3.5.2	Accessing Earlier Results . . . . .	47
3.5.3	Splitting Expressions Over Several Lines . . . . .	47
3.5.4	Comments and Descriptions . . . . .	47
3.5.5	Control of Result Types . . . . .	48
3.5.6	Using system commands . . . . .	49
3.5.7	Using undo . . . . .	50
3.6	Data Structures in Axiom . . . . .	53
3.6.1	Lists . . . . .	53
3.6.2	Segmented Lists . . . . .	61
3.6.3	Streams . . . . .	62
3.6.4	Arrays, Vectors, Strings, and Bits . . . . .	64
3.6.5	Flexible Arrays . . . . .	67
3.7	Functions, Choices, and Loops . . . . .	70
3.7.1	Reading Code from a File . . . . .	70
3.7.2	Blocks . . . . .	70
3.7.3	Functions . . . . .	74
3.7.4	Choices . . . . .	77
3.7.5	Loops . . . . .	77
3.8	Numbers . . . . .	87
3.9	Data Structures . . . . .	95
3.10	Expanding to Higher Dimensions . . . . .	102
3.11	Writing Your Own Functions . . . . .	104
3.12	Polynomials . . . . .	109
3.13	Limits . . . . .	111
3.14	Series . . . . .	113
3.15	Derivatives . . . . .	115
3.16	Integration . . . . .	118
3.17	Differential Equations . . . . .	121
3.18	Solution of Equations . . . . .	124
<b>4</b>	<b>Graphics</b> . . . . .	<b>127</b>
4.0.1	Plotting 2D graphs . . . . .	128
4.0.2	Palette . . . . .	133
4.0.3	Two-Dimensional Control-Panel . . . . .	134
4.0.4	Operations for Two-Dimensional Graphics . . . . .	137
4.0.5	Building Two-Dimensional Graphs Manually . . . . .	140
4.0.6	Appending a Graph to a Viewport Window Containing a Graph . . .	149
4.0.7	Plotting 3D Graphs . . . . .	150

4.0.8	Three-Dimensional Options . . . . .	152
4.0.9	Three-Dimensional Control-Panel . . . . .	153
4.0.10	Operations for Three-Dimensional Graphics . . . . .	158
4.0.11	Customization using .Xdefaults . . . . .	161
<b>5</b>	<b>Using Types and Modes</b>	<b>163</b>
5.1	The Basic Idea . . . . .	163
5.1.1	Domain Constructors . . . . .	165
5.2	Writing Types and Modes . . . . .	170
5.2.1	Types with No Arguments . . . . .	171
5.2.2	Types with One Argument . . . . .	171
5.2.3	Types with More Than One Argument . . . . .	173
5.2.4	Modes . . . . .	173
5.2.5	Abbreviations . . . . .	173
5.3	Declarations . . . . .	175
5.4	Records . . . . .	178
5.5	Unions . . . . .	182
5.5.1	Unions Without Selectors . . . . .	182
5.5.2	Unions With Selectors . . . . .	185
5.6	The “Any” Domain . . . . .	187
5.7	Conversion . . . . .	188
5.8	Subdomains Again . . . . .	191
5.9	Package Calling and Target Types . . . . .	194
5.10	Resolving Types . . . . .	198
5.11	Exposing Domains and Packages . . . . .	200
5.12	Commands for Snooping . . . . .	202
<b>6</b>	<b>Using HyperDoc</b>	<b>205</b>
6.1	Headings . . . . .	206
6.2	Key Definitions . . . . .	206
6.3	Scroll Bars . . . . .	207
6.4	Input Areas . . . . .	207
6.5	Radio Buttons and Toggles . . . . .	208
6.6	Search Strings . . . . .	208
6.6.1	Logical Searches . . . . .	209
6.7	Example Pages . . . . .	209
6.8	X Window Resources for HyperDoc . . . . .	209
<b>7</b>	<b>Input Files and Output Styles</b>	<b>211</b>
7.1	Input Files . . . . .	211
7.2	The .axiom.input File . . . . .	212
7.3	Common Features of Using Output Formats . . . . .	212
7.4	Monospace Two-Dimensional Mathematical Format . . . . .	214
7.5	TeX Format . . . . .	214
7.6	IBM Script Formula Format . . . . .	215
7.7	FORTTRAN Format . . . . .	216



<b>8</b>	<b>Axiom System Commands</b>	<b>221</b>
8.1	Introduction . . . . .	221
8.2	)abbreviation . . . . .	222
8.3	)boot . . . . .	224
8.4	)cd . . . . .	224
8.5	)close . . . . .	225
8.6	)clear . . . . .	225
8.7	)compile . . . . .	227
8.8	)display . . . . .	229
8.9	)edit . . . . .	230
8.10	)fin . . . . .	231
8.11	)frame . . . . .	231
8.12	)hd . . . . .	233
8.13	)help . . . . .	233
8.14	)history . . . . .	234
8.15	)library . . . . .	236
8.16	)lisp . . . . .	237
8.17	)ltrace . . . . .	238
8.18	)pquit . . . . .	238
8.19	)quit . . . . .	239
8.20	)read . . . . .	239
8.21	)set . . . . .	240
8.22	)show . . . . .	241
8.23	)spool . . . . .	242
8.24	)synonym . . . . .	242
8.25	)system . . . . .	243
8.26	)trace . . . . .	243
8.27	)undo . . . . .	247
8.28	)what . . . . .	249
8.29	Makefile . . . . .	250

## Volume 2: Axiom Users Guide

0.1	Makefile . . . . .	1
<b>1</b>	<b>Writing Spad Code</b>	<b>3</b>
1.1	The Description: label and the )describe command . . . . .	3

**Volume 3: Axiom Programmers Guide**

0.1 Makefile . . . . . 1

## Volume 4: Axiom Developers Guide

0.1	How Axiom Builds . . . . .	1
0.1.1	The environment variables . . . . .	1
0.1.2	The build step . . . . .	2
0.1.3	Where each output file is created . . . . .	6
0.2	How Axiom Works . . . . .	12
0.2.1	Input and Type Selection . . . . .	12
0.2.2	A simple integral, expansion 1 interpreter . . . . .	18
0.2.3	A simple integral, expansion 2 integrate . . . . .	22
0.2.4	A simple integral, expansion 2 internalIntegrate . . . . .	24
0.2.5	A simple integral, expansion 3 univariate . . . . .	27
0.2.6	A simple integral, expansion 4 integrate . . . . .	29
0.2.7	A simple integral, expansion 5 monomialIntegrate . . . . .	30
0.2.8	A simple integral, expansion 6 HermiteIntegrate . . . . .	34
0.3	Tools . . . . .	37
0.3.1	svn . . . . .	37
0.3.2	git . . . . .	37
0.3.3	cvs . . . . .	37
0.4	Common Lisps . . . . .	41
0.4.1	GCL . . . . .	41
0.4.2	CCL . . . . .	42
0.4.3	CMU CL . . . . .	42
0.4.4	Franz Lisp . . . . .	42
0.4.5	Lucid Common Lisp . . . . .	42
0.4.6	Symbolics Common Lisp . . . . .	43
0.4.7	Golden Common Lisp . . . . .	43
0.4.8	VM/LISP 370 . . . . .	43
0.4.9	Maclisp . . . . .	43
0.5	Literate Programming . . . . .	43
0.5.1	Pamphlet files . . . . .	43
0.5.2	noweb . . . . .	44
0.6	Databases . . . . .	46
0.6.1	libcheck . . . . .	46
0.6.2	asq . . . . .	46
0.7	Axiom internal representations . . . . .	46
0.8	axiom command . . . . .	49
0.9	help command documentation . . . . .	49
0.9.1	help documentation for algebra . . . . .	49
0.9.2	Adding help documentation in Makefile . . . . .	50
0.9.3	Using help documentation for regression testing . . . . .	51
0.9.4	help documentation as algebra test files . . . . .	51
0.10	debugsys . . . . .	51
0.10.1	debugging hyperdoc . . . . .	52
0.11	Understanding a compiled function . . . . .	52
0.12	The axiom.input startup file . . . . .	61

0.13	Where are Axiom symbols stored? . . . . .	61
0.14	Translating individual boot files to common lisp . . . . .	64
0.15	Directories . . . . .	65
0.15.1	The mnt/linux/bin directory . . . . .	65
0.15.2	The mnt/linux/doc directory . . . . .	67
0.15.3	The mnt/linux/algebra directory . . . . .	70
0.15.4	The mnt/linux/lib directory . . . . .	71
0.15.5	The mnt/linux/lib directory . . . . .	73
0.16	The )set command . . . . .	73
0.16.1	The example bug . . . . .	78
0.16.2	Operating system level I/O trace (strace) . . . . .	95
0.17	How to make graphs in algebra books . . . . .	96
0.18	Adding or Editing pages in Hyperdoc . . . . .	97
0.19	Graphviz file creation . . . . .	98
0.20	Adding Algebra . . . . .	100
0.20.1	Adding algebra to the books . . . . .	100
0.20.2	Creating a stand-alone pamphlet file . . . . .	112
0.21	Makefile . . . . .	112

## Volume 5: Axiom Interpreter

<b>1 Credits</b>	<b>1</b>
1.0.1 defvar \$credits . . . . .	1
<b>2 The Interpreter</b>	<b>5</b>
<b>3 The Fundamental Data Structures</b>	<b>7</b>
3.1 The global variables . . . . .	7
3.1.1 defvar \$current-directory . . . . .	7
3.1.2 defvar \$current-directory . . . . .	7
3.1.3 defvar \$defaultMsgDatabaseName . . . . .	8
3.1.4 defvar \$defaultMsgDatabaseName . . . . .	8
3.1.5 defvar \$directory-list . . . . .	8
3.1.6 defvar \$directory-list . . . . .	8
3.1.7 defvar \$InitialModemapFrame . . . . .	9
3.1.8 defvar \$InitialModemapFrame . . . . .	9
3.1.9 defvar \$library-directory-list . . . . .	9
3.1.10 defvar \$library-directory-list . . . . .	9
3.1.11 defvar \$msgDatabaseName . . . . .	9
3.1.12 defvar \$msgDatabaseName . . . . .	10
3.1.13 defvar \$openServerIfTrue . . . . .	10
3.1.14 defvar \$openServerIfTrue . . . . .	10
3.1.15 defvar \$relative-directory-list . . . . .	10
3.1.16 defvar \$relative-directory-list . . . . .	11
3.1.17 defvar \$relative-library-directory-list . . . . .	11
3.1.18 defvar \$relative-library-directory-list . . . . .	11
3.1.19 defvar \$spadroot . . . . .	11
3.1.20 defvar \$spadroot . . . . .	12
3.1.21 defvar \$SpadServer . . . . .	12
3.1.22 defvar \$SpadServer . . . . .	12
3.1.23 defvar \$SpadServerName . . . . .	12
3.1.24 defvar \$SpadServerName . . . . .	13
<b>4 Starting Axiom</b>	<b>15</b>
4.1 Variables Used . . . . .	15
4.2 Data Structures . . . . .	15
4.3 Functions . . . . .	15
4.3.1 Set the restart hook . . . . .	15
4.3.2 restart function (The restart function) . . . . .	16
4.3.3 defun Non-interactive restarts . . . . .	18
4.3.4 defun The startup banner messages . . . . .	19
4.3.5 defun Make a vector of filler characters . . . . .	20
4.3.6 Starts the interpreter but do not read in profiles . . . . .	20
4.3.7 defvar \$quitTag . . . . .	20

4.3.8	defun runspad . . . . .	21
4.3.9	defun Reset the stack limits . . . . .	21
<b>5</b>	<b>Handling Terminal Input</b>	<b>23</b>
5.1	Streams . . . . .	23
5.1.1	defvar \$curinstream . . . . .	23
5.1.2	defvar \$curoutstream . . . . .	23
5.1.3	defvar \$errorinstream . . . . .	23
5.1.4	defvar \$erroroutstream . . . . .	24
5.1.5	defvar \$*eof* . . . . .	24
5.1.6	defvar \$*whitespace* . . . . .	24
5.1.7	defvar \$InteractiveMode . . . . .	24
5.1.8	defvar \$boot . . . . .	25
5.1.9	Top-level read-parse-eval-print loop . . . . .	25
5.1.10	defun ncIntLoop . . . . .	25
5.1.11	defvar \$intTopLevel . . . . .	26
5.1.12	defvar \$intRestart . . . . .	26
5.1.13	defun intloop . . . . .	26
5.1.14	defvar \$ncMsgList . . . . .	27
5.1.15	defun SpadInterpretStream . . . . .	27
5.1.16	defvar \$promptMsg . . . . .	28
5.1.17	defun GCL cmpnote function . . . . .	28
5.1.18	defvar \$newcompErrorCount . . . . .	28
5.1.19	defvar \$nopus . . . . .	28
5.2	The Read-Eval-Print Loop . . . . .	30
5.2.1	defun intloopReadConsole . . . . .	30
5.3	Helper Functions . . . . .	31
5.3.1	Get the value of an environment variable . . . . .	31
5.3.2	defvar \$intCoerceFailure . . . . .	32
5.3.3	defvar \$intSpadReader . . . . .	32
5.3.4	defun InterpExecuteSpadSystemCommand . . . . .	32
5.3.5	defun ExecuteInterpSystemCommand . . . . .	33
5.3.6	defun Handle Synonyms . . . . .	33
5.3.7	defun Synonym File Reader . . . . .	33
5.3.8	defun init-memory-config . . . . .	34
5.3.9	Set spadroot to be the AXIOM shell variable . . . . .	35
5.3.10	Does the string start with this prefix? . . . . .	36
5.3.11	defun Interpret a line of lisp code . . . . .	36
5.3.12	Get the current directory . . . . .	36
5.3.13	Prepend the absolute path to a filename . . . . .	36
5.3.14	Make the initial modemap frame . . . . .	37
5.3.15	defun nclloopEscaped . . . . .	37
5.3.16	defun intloopProcessString . . . . .	37
5.3.17	defun nclloopParse . . . . .	38
5.3.18	defun next . . . . .	38
5.3.19	defun next1 . . . . .	38

5.3.20	defun incString . . . . .	39
5.3.21	Call the garbage collector . . . . .	39
5.3.22	defun reroot . . . . .	40
5.3.23	defun setCurrentLine . . . . .	41
5.3.24	Show the Axiom prompt . . . . .	42
5.3.25	defvar \$frameAlist . . . . .	43
5.3.26	defvar \$frameNumber . . . . .	43
5.3.27	defvar \$currentFrameNum . . . . .	43
5.3.28	defvar \$EndServerSession . . . . .	43
5.3.29	defvar \$NeedToSignalSessionManager . . . . .	44
5.3.30	defvar \$sockBufferLength . . . . .	44
5.3.31	READ-LINE in an Axiom server system . . . . .	44
5.3.32	defun protectedEVAL . . . . .	47
5.3.33	defvar \$QuietCommand . . . . .	47
5.3.34	defun executeQuietCommand . . . . .	47
5.3.35	defun parseAndInterpret . . . . .	48
5.3.36	defun parseFromString . . . . .	48
5.3.37	defvar \$interpOnly . . . . .	49
5.3.38	defvar \$minivectorNames . . . . .	49
5.3.39	defvar \$domPvar . . . . .	49
5.3.40	defun processInteractive . . . . .	49
5.3.41	defvar \$ProcessInteractiveValue . . . . .	52
5.3.42	defvar \$HTCompanionWindowID . . . . .	52
5.3.43	defun processInteractive1 . . . . .	52
5.3.44	defun interpretTopLevel . . . . .	53
5.3.45	defvar \$genValue . . . . .	53
5.3.46	defun Type analyzes and evaluates expression x, returns object . . . . .	54
5.3.47	defun Dispatcher for the type analysis routines . . . . .	54
5.3.48	defun interpret2 . . . . .	55
5.3.49	defun Result Output Printing . . . . .	56
5.3.50	defun printStatisticsSummary . . . . .	57
5.3.51	defun printStorage . . . . .	58
5.3.52	defun printTypeAndTime . . . . .	58
5.3.53	defun printTypeAndTimeNormal . . . . .	59
5.3.54	defun printTypeAndTimeSaturn . . . . .	60
5.3.55	defun printAsTeX . . . . .	61
5.3.56	defun sameUnionBranch . . . . .	61
5.3.57	defun msgText . . . . .	61
5.3.58	defun Right-justify the Type output . . . . .	62
5.3.59	defun Destructively fix quotes in strings . . . . .	62
5.3.60	Include a file into the stream . . . . .	63
5.3.61	defun intloopInclude0 . . . . .	63
5.3.62	defun intloopProcess . . . . .	64
5.3.63	defun intloopSpadProcess . . . . .	64
5.3.64	defun intloopSpadProcess,interp . . . . .	65
5.3.65	defun phParse . . . . .	66



5.3.66	defun phIntReportMsgs . . . . .	66
5.3.67	defun phInterpret . . . . .	67
5.3.68	defun intInterpretPform . . . . .	67
5.3.69	defun zeroOneTran . . . . .	68
5.3.70	defun ncConversationPhase . . . . .	68
5.3.71	defun ncConversationPhase,wrapup . . . . .	68
5.3.72	defun ncError . . . . .	69
5.3.73	defun intloopEchoParse . . . . .	69
5.3.74	defun nclloopPrintLines . . . . .	70
5.3.75	defun mkLineList . . . . .	70
5.3.76	defun nonBlank . . . . .	71
5.3.77	defun nclloopDQlines . . . . .	71
5.3.78	defun poGlobalLinePosn . . . . .	72
5.3.79	defun streamChop . . . . .	72
5.3.80	defun nclloopInclude0 . . . . .	73
5.3.81	defun incStream . . . . .	73
5.3.82	defun incRenumber . . . . .	74
5.3.83	defun incZip . . . . .	74
5.3.84	defun incZip1 . . . . .	74
5.3.85	defun incIgen . . . . .	75
5.3.86	defun incIgen1 . . . . .	75
5.3.87	defun incRenumberLine . . . . .	75
5.3.88	defun incRenumberItem . . . . .	76
5.3.89	defun incHandleMessage . . . . .	76
5.3.90	defun incLude . . . . .	76
5.3.91	defmacro Rest . . . . .	77
5.3.92	defvar \$Top . . . . .	77
5.3.93	defvar \$IfSkipToEnd . . . . .	77
5.3.94	defvar \$IfKeepPart . . . . .	77
5.3.95	defvar \$IfSkipPart . . . . .	78
5.3.96	defvar \$ElseifSkipToEnd . . . . .	78
5.3.97	defvar \$ElseifKeepPart . . . . .	78
5.3.98	defvar \$ElseifSkipPart . . . . .	78
5.3.99	defvar \$ElseSkipToEnd . . . . .	78
5.3.100	defvar \$ElseKeepPart . . . . .	79
5.3.101	defvar \$Top? . . . . .	79
5.3.102	defvar \$If? . . . . .	79
5.3.103	defvar \$Elseif? . . . . .	79
5.3.104	defvar \$Else? . . . . .	80
5.3.105	defvar \$SkipEnd? . . . . .	80
5.3.106	defvar \$KeepPart? . . . . .	80
5.3.107	defvar \$SkipPart? . . . . .	81
5.3.108	defvar \$Skipping? . . . . .	81
5.3.109	defun incLude1 . . . . .	81
5.3.110	defun xlPrematureEOF . . . . .	86
5.3.111	defun xlMsg . . . . .	86

5.3.112 defun xLOK . . . . .	86
5.3.113 defun xLOK1 . . . . .	86
5.3.114 defun incAppend . . . . .	87
5.3.115 defun incAppend1 . . . . .	87
5.3.116 defun incLine . . . . .	87
5.3.117 defun incLine1 . . . . .	88
5.3.118 defun inclmsgPrematureEOF . . . . .	88
5.3.119 defun theorigin . . . . .	88
5.3.120 defun porigin . . . . .	88
5.3.121 defun ifCond . . . . .	89
5.3.122 defun xLSkip . . . . .	89
5.3.123 defun xLSay . . . . .	89
5.3.124 defun inclmsgSay . . . . .	90
5.3.125 defun theid . . . . .	90
5.3.126 defun xLNoSuchFile . . . . .	90
5.3.127 defun inclmsgNoSuchFile . . . . .	91
5.3.128 defun thefname . . . . .	91
5.3.129 defun pfname . . . . .	91
5.3.130 defun xLCannotRead . . . . .	91
5.3.131 defun inclmsgCannotRead . . . . .	92
5.3.132 defun xLFileCycle . . . . .	92
5.3.133 defun inclmsgFileCycle . . . . .	92
5.3.134 defun xLConActive . . . . .	93
5.3.135 defun inclmsgConActive . . . . .	93
5.3.136 defun xLConStill . . . . .	94
5.3.137 defun inclmsgConStill . . . . .	94
5.3.138 defun xLConsole . . . . .	94
5.3.139 defun inclmsgConsole . . . . .	94
5.3.140 defun xLSkippingFin . . . . .	95
5.3.141 defun inclmsgFinSkipped . . . . .	95
5.3.142 defun xLPrematureFin . . . . .	95
5.3.143 defun inclmsgPrematureFin . . . . .	95
5.3.144 defun assertCond . . . . .	96
5.3.145 defun xLIfSyntax . . . . .	96
5.3.146 defun inclmsgIfSyntax . . . . .	97
5.3.147 defun xLIfBug . . . . .	97
5.3.148 defun inclmsgIfBug . . . . .	97
5.3.149 defun xLCmdBug . . . . .	98
5.3.150 defun inclmsgCmdBug . . . . .	98
5.3.151 defvar \$incCommands . . . . .	98
5.3.152 defvar \$pfMacros . . . . .	98
5.3.153 defun incClassify . . . . .	99
5.3.154 defun incCommand? . . . . .	100
5.3.155 defun incPrefix? . . . . .	100
5.3.156 defun incCommandTail . . . . .	101
5.3.157 defun incDrop . . . . .	101

5.3.158 defun inclFname . . . . .	102
5.3.159 defun incFileInput . . . . .	102
5.3.160 defun incConsoleInput . . . . .	102
5.3.161 defun incNConsoles . . . . .	103
5.3.162 defun incActive? . . . . .	103
5.3.163 defun incRgen . . . . .	103
5.3.164 defun Delay . . . . .	103
5.3.165 defvar \$StreamNil . . . . .	104
5.3.166 defvar \$StreamNil . . . . .	104
5.3.167 defun incRgen1 . . . . .	104
<b>6 The Token Scanner</b>	<b>105</b>
6.0.168 defvar \$scanKeyWords . . . . .	105
6.0.169 defvar \$infgeneric . . . . .	107
6.0.170 defun lineoftoks . . . . .	108
6.0.171 defun nextline . . . . .	110
6.0.172 defun scanIgnoreLine . . . . .	110
6.0.173 defun constoken . . . . .	111
6.0.174 defun scanToken . . . . .	111
6.0.175 defun lfid . . . . .	112
6.0.176 defun startsComment? . . . . .	113
6.0.177 defun scanComment . . . . .	113
6.0.178 defun lfcomment . . . . .	114
6.0.179 defun startsNegComment? . . . . .	114
6.0.180 defun scanNegComment . . . . .	114
6.0.181 defun lfnegcomment . . . . .	115
6.0.182 defun punctuation? . . . . .	115
6.0.183 defun scanPunct . . . . .	115
6.0.184 defun subMatch . . . . .	116
6.0.185 defun substringMatch . . . . .	116
6.0.186 defun scanKeyTr . . . . .	117
6.0.187 defun keyword . . . . .	118
6.0.188 defun keyword? . . . . .	118
6.0.189 defun scanPossFloat . . . . .	118
6.0.190 defun digit? . . . . .	119
6.0.191 defun lfkey . . . . .	119
6.0.192 defun spleI . . . . .	119
6.0.193 defun spleI1 . . . . .	120
6.0.194 defun scanEsc . . . . .	120
6.0.195 defvar \$scanCloser . . . . .	122
6.0.196 defun scanCloser? . . . . .	123
6.0.197 defun scanWord . . . . .	123
6.0.198 defun scanExponent . . . . .	124
6.0.199 defun lffloat . . . . .	125
6.0.200 defmacro idChar? . . . . .	125
6.0.201 defun scanW . . . . .	125

6.0.202 defun posend . . . . .	126
6.0.203 defun scanSpace . . . . .	127
6.0.204 defun lfspaces . . . . .	127
6.0.205 defun scanString . . . . .	127
6.0.206 defun lfstring . . . . .	128
6.0.207 defun scanS . . . . .	128
6.0.208 defun scanTransform . . . . .	129
6.0.209 defun scanNumber . . . . .	129
6.0.210 defun rdigit? . . . . .	131
6.0.211 defun lfinteger . . . . .	131
6.0.212 defun lfrinteger . . . . .	131
6.0.213 defun scanCheckRadix . . . . .	131
6.0.214 defun scanEscape . . . . .	132
6.0.215 defun scanError . . . . .	132
6.0.216 defun lferror . . . . .	133
6.0.217 defvar \$scanKeyTable . . . . .	133
6.0.218 defun scanKeyTableCons . . . . .	133
6.0.219 defvar \$scanDict . . . . .	134
6.0.220 defun scanDictCons . . . . .	134
6.0.221 defun scanInsert . . . . .	135
6.0.222 defvar \$scanPun . . . . .	136
6.0.223 defun scanPunCons . . . . .	137
<b>7 Input Stream Parser</b>	<b>139</b>
7.0.224 defun Input Stream Parser . . . . .	139
7.0.225 defun npItem . . . . .	140
7.0.226 defun npItem1 . . . . .	140
7.0.227 defun npFirstTok . . . . .	141
7.0.228 defun Push one item onto \$stack . . . . .	141
7.0.229 defun Pop one item off \$stack . . . . .	142
7.0.230 defun Pop the second item off \$stack . . . . .	142
7.0.231 defun Pop the third item off \$stack . . . . .	142
7.0.232 defun npQualDef . . . . .	143
7.0.233 defun Advance over a keyword . . . . .	143
7.0.234 defun Advance the input stream . . . . .	143
7.0.235 defun npComma . . . . .	144
7.0.236 defun npTuple . . . . .	144
7.0.237 defun npCommaBackSet . . . . .	144
7.0.238 defun npQualifiedDefinition . . . . .	145
7.0.239 defun npQualified . . . . .	145
7.0.240 defun npDefinitionOrStatement . . . . .	145
7.0.241 defun npBackTrack . . . . .	146
7.0.242 defun npGives . . . . .	146
7.0.243 defun npLambda . . . . .	146
7.0.244 defun npType . . . . .	147
7.0.245 defun npMatch . . . . .	148

7.0.246 defun npSuch . . . . .	148
7.0.247 defun npWith . . . . .	148
7.0.248 defun npCompMissing . . . . .	149
7.0.249 defun npMissing . . . . .	149
7.0.250 defun npRestore . . . . .	150
7.0.251 defun Peek for keyword s, no advance of token stream . . . . .	150
7.0.252 defun npCategoryL . . . . .	150
7.0.253 defun npCategory . . . . .	151
7.0.254 defun npSCategory . . . . .	151
7.0.255 defun npSignature . . . . .	152
7.0.256 defun npSigItemlist . . . . .	152
7.0.257 defun npListing . . . . .	153
7.0.258 defun Always produces a list, fn is applied to it . . . . .	153
7.0.259 defun npSigItem . . . . .	154
7.0.260 defun npTypeVariable . . . . .	154
7.0.261 defun npSignatureDefinee . . . . .	154
7.0.262 defun npTypeVariablelist . . . . .	155
7.0.263 defun npSigDecl . . . . .	155
7.0.264 defun npPrimary . . . . .	155
7.0.265 defun npPrimary2 . . . . .	156
7.0.266 defun npADD . . . . .	156
7.0.267 defun npAdd . . . . .	157
7.0.268 defun npAtom2 . . . . .	157
7.0.269 defun npInfixOperator . . . . .	158
7.0.270 defun npInfixOp . . . . .	159
7.0.271 defun npPrefixColon . . . . .	159
7.0.272 defun npApplication . . . . .	160
7.0.273 defun npDotted . . . . .	160
7.0.274 defun npAnyNo . . . . .	160
7.0.275 defun npSelector . . . . .	161
7.0.276 defun npApplication2 . . . . .	161
7.0.277 defun npPrimary1 . . . . .	162
7.0.278 defun npMacro . . . . .	162
7.0.279 defun npMdef . . . . .	162
7.0.280 defun npMDEF . . . . .	163
7.0.281 defun npMDEFinition . . . . .	163
7.0.282 defun npFix . . . . .	164
7.0.283 defun npLet . . . . .	164
7.0.284 defun npLetQualified . . . . .	164
7.0.285 defun npDefinition . . . . .	165
7.0.286 defun npDefinitionItem . . . . .	165
7.0.287 defun npTyping . . . . .	166
7.0.288 defun npDefaultItemlist . . . . .	166
7.0.289 defun npSDefaultItem . . . . .	167
7.0.290 defun npDefaultItem . . . . .	167
7.0.291 defun npDefaultDecl . . . . .	168

7.0.292 defun npStatement . . . . .	168
7.0.293 defun npExport . . . . .	169
7.0.294 defun npLocalItemList . . . . .	169
7.0.295 defun npSLocalItem . . . . .	170
7.0.296 defun npLocalItem . . . . .	170
7.0.297 defun npLocalDecl . . . . .	170
7.0.298 defun npLocal . . . . .	171
7.0.299 defun npFree . . . . .	171
7.0.300 defun npInline . . . . .	172
7.0.301 defun npIterate . . . . .	172
7.0.302 defun npBreak . . . . .	172
7.0.303 defun npLoop . . . . .	173
7.0.304 defun npIterators . . . . .	173
7.0.305 defun npIterator . . . . .	174
7.0.306 defun npSuchThat . . . . .	174
7.0.307 defun Apply argument 0 or more times . . . . .	175
7.0.308 defun npWhile . . . . .	175
7.0.309 defun npForIn . . . . .	175
7.0.310 defun npReturn . . . . .	176
7.0.311 defun npVoid . . . . .	177
7.0.312 defun npExpress . . . . .	177
7.0.313 defun npExpress1 . . . . .	177
7.0.314 defun npConditionalStatement . . . . .	178
7.0.315 defun npImport . . . . .	178
7.0.316 defun npQualTypelist . . . . .	178
7.0.317 defun npSQualTypelist . . . . .	179
7.0.318 defun npQualType . . . . .	179
7.0.319 defun npAndOr . . . . .	179
7.0.320 defun npEncAp . . . . .	180
7.0.321 defun npEncl . . . . .	180
7.0.322 defun npAtom1 . . . . .	181
7.0.323 defun npPDefinition . . . . .	181
7.0.324 defun npDollar . . . . .	181
7.0.325 defun npConstTok . . . . .	182
7.0.326 defun npBDefinition . . . . .	183
7.0.327 defun npBracketed . . . . .	183
7.0.328 defun npParened . . . . .	183
7.0.329 defun npBracked . . . . .	184
7.0.330 defun npBraced . . . . .	184
7.0.331 defun npAngleBared . . . . .	184
7.0.332 defun npDefn . . . . .	185
7.0.333 defun npDef . . . . .	185
7.0.334 defun npBPileDefinition . . . . .	186
7.0.335 defun npPileBracketed . . . . .	186
7.0.336 defun npPileDefinitionlist . . . . .	187
7.0.337 defun npListAndRecover . . . . .	187

7.0.338 defun npRecoverTrap . . . . .	188
7.0.339 defun npMoveTo . . . . .	189
7.0.340 defun syIgnoredFromTo . . . . .	189
7.0.341 defun syGeneralErrorHere . . . . .	190
7.0.342 defun sySpecificErrorHere . . . . .	190
7.0.343 defun sySpecificErrorAtToken . . . . .	190
7.0.344 defun npDefinitionlist . . . . .	191
7.0.345 defun npSemiListing . . . . .	191
7.0.346 defun npSemiBackSet . . . . .	191
7.0.347 defun npRule . . . . .	191
7.0.348 defun npSingleRule . . . . .	192
7.0.349 defun npDefTail . . . . .	192
7.0.350 defun npDefaultValue . . . . .	192
7.0.351 defun npWConditional . . . . .	193
7.0.352 defun npConditional . . . . .	193
7.0.353 defun npElse . . . . .	194
7.0.354 defun npBacksetElse . . . . .	195
7.0.355 defun npLogical . . . . .	195
7.0.356 defun npDisjand . . . . .	195
7.0.357 defun npDiscrim . . . . .	195
7.0.358 defun npQuiver . . . . .	196
7.0.359 defun npRelation . . . . .	196
7.0.360 defun npSynthetic . . . . .	196
7.0.361 defun npBy . . . . .	197
7.0.362 defun . . . . .	197
7.0.363 defun npSegment . . . . .	198
7.0.364 defun npArith . . . . .	198
7.0.365 defun npSum . . . . .	199
7.0.366 defun npTerm . . . . .	199
7.0.367 defun npRemainder . . . . .	199
7.0.368 defun npProduct . . . . .	200
7.0.369 defun npPower . . . . .	200
7.0.370 defun npAmpersandFrom . . . . .	200
7.0.371 defun npFromdom . . . . .	200
7.0.372 defun npFromdom1 . . . . .	201
7.0.373 defun npAmpersand . . . . .	202
7.0.374 defun npName . . . . .	202
7.0.375 defvar \$npPParg . . . . .	202
7.0.376 defun npId . . . . .	202
7.0.377 defun npSymbolVariable . . . . .	203
7.0.378 defun npRightAssoc . . . . .	204
7.0.379 defun $p \circ p \circ p \circ p = (((p \circ p) \circ p) \circ p)$ . . . . .	204
7.0.380 defun npInfGeneric . . . . .	205
7.0.381 defun npDDInfKey . . . . .	206
7.0.382 defun npInfKey . . . . .	206
7.0.383 defun npPushId . . . . .	207

7.0.384	defvar \$npPParg . . . . .	207
7.0.385	defun npPP . . . . .	207
7.0.386	defun npPPff . . . . .	208
7.0.387	defun npPPg . . . . .	208
7.0.388	defun npPPf . . . . .	209
7.0.389	defun npEnclosed . . . . .	209
7.0.390	defun npState . . . . .	210
7.0.391	defun npTrap . . . . .	210
7.0.392	defun npTrapForm . . . . .	210
7.0.393	defun npVariable . . . . .	211
7.0.394	defun npVariablelist . . . . .	211
7.0.395	defun npVariableName . . . . .	211
7.0.396	defun npDecl . . . . .	212
7.0.397	defun npParenthesized . . . . .	212
7.0.398	defun npParenthesize . . . . .	213
7.0.399	defun npMissingMate . . . . .	213
7.0.400	defun npExit . . . . .	213
7.0.401	defun npPileExit . . . . .	214
7.0.402	defun npAssign . . . . .	214
7.0.403	defun npAssignment . . . . .	215
7.0.404	defun npAssignVariable . . . . .	215
7.0.405	defun npColon . . . . .	215
7.0.406	defun npTagged . . . . .	216
7.0.407	defun npTypedForm1 . . . . .	216
7.0.408	defun npTypified . . . . .	216
7.0.409	defun npTypeStyle . . . . .	217
7.0.410	defun npPretend . . . . .	217
7.0.411	defun npColonQuery . . . . .	217
7.0.412	defun npCoerceTo . . . . .	218
7.0.413	defun npTypedForm . . . . .	218
7.0.414	defun npRestrict . . . . .	218
7.0.415	defun npListofFun . . . . .	219
7.1	Macro handling . . . . .	219
7.1.1	defun phMacro . . . . .	219
7.1.2	defun macroExpanded . . . . .	220
7.1.3	defun macExpand . . . . .	220
7.1.4	defun macApplication . . . . .	221
7.1.5	defun mac0MLambdaApply . . . . .	221
7.1.6	defun mac0ExpandBody . . . . .	222
7.1.7	defun mac0InfiniteExpansion . . . . .	223
7.1.8	defun mac0InfiniteExpansion,name . . . . .	224
7.1.9	defun mac0GetName . . . . .	224
7.1.10	defun macId . . . . .	225
7.1.11	defun mac0Get . . . . .	226
7.1.12	defun macWhere . . . . .	226
7.1.13	defun macWhere,mac . . . . .	226



7.1.14	defun macLambda . . . . .	226
7.1.15	defun macLambda,mac . . . . .	227
7.1.16	defun Add appropriate definition the a Macro pform . . . . .	227
7.1.17	defun Add a macro to the global pfMacros list . . . . .	228
7.1.18	defun macSubstituteOuter . . . . .	228
7.1.19	defun mac0SubstituteOuter . . . . .	229
7.1.20	defun macLambdaParameterHandling . . . . .	229
7.1.21	defun macSubstituteId . . . . .	230
<b>8</b>	<b>Pftrees</b>	<b>231</b>
8.1	Abstract Syntax Trees Overview . . . . .	231
8.2	Structure handlers . . . . .	233
8.2.1	defun pfGlobalLinePosn . . . . .	233
8.2.2	defun pfCharPosn . . . . .	233
8.2.3	defun pfLinePosn . . . . .	233
8.2.4	defun pfFileName . . . . .	234
8.2.5	defun pfCopyWithPos . . . . .	234
8.2.6	defun pfMapParts . . . . .	234
8.2.7	defun pf0ApplicationArgs . . . . .	235
8.2.8	defun pf0FlattenSyntacticTuple . . . . .	235
8.2.9	defun pfSourcePosition . . . . .	236
8.2.10	defun Convert a Sequence node to a list . . . . .	236
8.2.11	defun pfSpread . . . . .	237
8.2.12	defun Deconstruct nodes to lists . . . . .	237
8.2.13	defun pfCheckMacroOut . . . . .	238
8.2.14	defun pfCheckArg . . . . .	239
8.2.15	defun pfCheckId . . . . .	239
8.2.16	defun pfFlattenApp . . . . .	239
8.2.17	defun pfCollect1? . . . . .	240
8.2.18	defun pfCollectVariable1 . . . . .	240
8.2.19	defun pfPushMacroBody . . . . .	241
8.2.20	defun pfSourceStok . . . . .	241
8.2.21	defun pfTransformArg . . . . .	242
8.2.22	defun pfTaggedToTyped1 . . . . .	242
8.2.23	defun pfSuch . . . . .	242
8.3	Special Nodes . . . . .	243
8.3.1	defun Create a Listof node . . . . .	243
8.3.2	defun pfNothing . . . . .	243
8.3.3	defun Is this a Nothing node? . . . . .	243
8.4	Leaves . . . . .	244
8.4.1	defun Create a Document node . . . . .	244
8.4.2	defun Construct an Id node . . . . .	244
8.4.3	defun Is this an Id node? . . . . .	244
8.4.4	defun Construct an Id leaf node . . . . .	244
8.4.5	defun Return the Id part . . . . .	245
8.4.6	defun Construct a Leaf node . . . . .	245

8.4.7	defun Is this a leaf node? . . . . .	245
8.4.8	defun Return the token position of a leaf node . . . . .	246
8.4.9	defun Return the Leaf Token . . . . .	246
8.4.10	defun Is this a Literal node? . . . . .	246
8.4.11	defun Create a LiteralClass node . . . . .	246
8.4.12	defun Return the LiteralString . . . . .	247
8.4.13	defun Return the parts of a tree node . . . . .	247
8.4.14	defun Return the argument unchanged . . . . .	247
8.4.15	defun pfPushBody . . . . .	247
8.4.16	defun An S-expression which people can read. . . . .	248
8.4.17	defun Create a human readable S-expression . . . . .	248
8.4.18	defun Construct a Symbol or Expression node . . . . .	249
8.4.19	defun Construct a Symbol leaf node . . . . .	249
8.4.20	defun Is this a Symbol node? . . . . .	250
8.4.21	defun Return the Symbol part . . . . .	250
8.5	Trees . . . . .	250
8.5.1	defun Construct a tree node . . . . .	250
8.5.2	defun Construct an Add node . . . . .	250
8.5.3	defun Construct an And node . . . . .	251
8.5.4	defun pfAttribute . . . . .	251
8.5.5	defun Return an Application node . . . . .	251
8.5.6	defun Return the Arg part of an Application node . . . . .	252
8.5.7	defun Return the Op part of an Application node . . . . .	252
8.5.8	defun Is this an And node? . . . . .	252
8.5.9	defun Return the Left part of an And node . . . . .	252
8.5.10	defun Return the Right part of an And node . . . . .	253
8.5.11	defun Flatten a list of lists . . . . .	253
8.5.12	defun Is this an Application node? . . . . .	253
8.5.13	defun Create an Assign node . . . . .	253
8.5.14	defun Is this an Assign node? . . . . .	254
8.5.15	defun Return the parts of an LhsItem of an Assign node . . . . .	254
8.5.16	defun Return the LhsItem of an Assign node . . . . .	254
8.5.17	defun Return the RHS of an Assign node . . . . .	254
8.5.18	defun Construct an application node for a brace . . . . .	255
8.5.19	defun Construct an Application node for brace-bars . . . . .	255
8.5.20	defun Construct an Application node for a bracket . . . . .	255
8.5.21	defun Construct an Application node for bracket-bars . . . . .	255
8.5.22	defun Create a Break node . . . . .	256
8.5.23	defun Is this a Break node? . . . . .	256
8.5.24	defun Return the From part of a Break node . . . . .	256
8.5.25	defun Construct a Coerceto node . . . . .	257
8.5.26	defun Is this a CoerceTo node? . . . . .	257
8.5.27	defun Return the Expression part of a CoerceTo node . . . . .	257
8.5.28	defun Return the Type part of a CoerceTo node . . . . .	257
8.5.29	defun Return the Body of a Collect node . . . . .	258
8.5.30	defun Return the Iterators of a Collect node . . . . .	258

8.5.31	defun Create a Collect node . . . . .	258
8.5.32	defun Is this a Collect node? . . . . .	258
8.5.33	defun pfDefinition . . . . .	259
8.5.34	defun Return the Lhs of a Definition node . . . . .	259
8.5.35	defun Return the Rhs of a Definition node . . . . .	259
8.5.36	defun Is this a Definition node? . . . . .	259
8.5.37	defun Return the parts of a Definition node . . . . .	260
8.5.38	defun Create a Do node . . . . .	260
8.5.39	defun Is this a Do node? . . . . .	260
8.5.40	defun Return the Body of a Do node . . . . .	260
8.5.41	defun Construct a Sequence node . . . . .	261
8.5.42	defun Construct an Exit node . . . . .	261
8.5.43	defun Is this an Exit node? . . . . .	261
8.5.44	defun Return the Cond part of an Exit . . . . .	261
8.5.45	defun Return the Expression part of an Exit . . . . .	262
8.5.46	defun Create an Export node . . . . .	262
8.5.47	defun Construct an Expression leaf node . . . . .	262
8.5.48	defun pfFirst . . . . .	262
8.5.49	defun Create an Application Fix node . . . . .	263
8.5.50	defun Create a Free node . . . . .	263
8.5.51	defun Is this a Free node? . . . . .	263
8.5.52	defun Return the parts of the Items of a Free node . . . . .	264
8.5.53	defun Return the Items of a Free node . . . . .	264
8.5.54	defun Construct a ForIn node . . . . .	264
8.5.55	defun Is this a ForIn node? . . . . .	264
8.5.56	defun Return all the parts of the LHS of a ForIn node . . . . .	265
8.5.57	defun Return the LHS part of a ForIn node . . . . .	265
8.5.58	defun Return the Whole part of a ForIn node . . . . .	265
8.5.59	defun pfFromDom . . . . .	265
8.5.60	defun Construct a Fromdom node . . . . .	266
8.5.61	defun Is this a Fromdom mode? . . . . .	266
8.5.62	defun Return the What part of a Fromdom node . . . . .	266
8.5.63	defun Return the Domain part of a Fromdom node . . . . .	267
8.5.64	defun Construct a Hide node . . . . .	267
8.5.65	defun pfIf . . . . .	267
8.5.66	defun Is this an If node? . . . . .	267
8.5.67	defun Return the Cond part of an If . . . . .	268
8.5.68	defun Return the Then part of an If . . . . .	268
8.5.69	defun pfIfThenOnly . . . . .	268
8.5.70	defun Return the Else part of an If . . . . .	268
8.5.71	defun Construct an Import node . . . . .	269
8.5.72	defun Construct an Iterate node . . . . .	269
8.5.73	defun Is this an Iterate node? . . . . .	269
8.5.74	defun Handle an infix application . . . . .	269
8.5.75	defun Create an Inline node . . . . .	270
8.5.76	defun pfLam . . . . .	270

8.5.77	defun pfLambda . . . . .	271
8.5.78	defun Return the Body part of a Lambda node . . . . .	271
8.5.79	defun Return the Rets part of a Lambda node . . . . .	271
8.5.80	defun Is this a Lambda node? . . . . .	271
8.5.81	defun Return the Args part of a Lambda node . . . . .	272
8.5.82	defun Return the Args of a Lambda Node . . . . .	272
8.5.83	defun Construct a Local node . . . . .	272
8.5.84	defun Is this a Local node? . . . . .	272
8.5.85	defun Return the parts of Items of a Local node . . . . .	273
8.5.86	defun Return the Items of a Local node . . . . .	273
8.5.87	defun Construct a Loop node . . . . .	273
8.5.88	defun pfLoop1 . . . . .	273
8.5.89	defun Is this a Loop node? . . . . .	274
8.5.90	defun Return the Iterators of a Loop node . . . . .	274
8.5.91	defun pf0LoopIterators . . . . .	274
8.5.92	defun pfLp . . . . .	274
8.5.93	defun Create a Macro node . . . . .	275
8.5.94	defun Is this a Macro node? . . . . .	275
8.5.95	defun Return the Lhs of a Macro node . . . . .	275
8.5.96	defun Return the Rhs of a Macro node . . . . .	275
8.5.97	defun Construct an MLambda node . . . . .	276
8.5.98	defun Is this an MLambda node? . . . . .	276
8.5.99	defun Return the Args of an MLambda . . . . .	276
8.5.100	defun Return the parts of an MLambda argument . . . . .	276
8.5.101	defun pfMLambdaBody . . . . .	277
8.5.102	defun Is this a Not node? . . . . .	277
8.5.103	defun Return the Arg part of a Not node . . . . .	277
8.5.104	defun Construct a NoValue node . . . . .	277
8.5.105	defun Is this a Novalue node? . . . . .	278
8.5.106	defun Return the Expr part of a Novalue node . . . . .	278
8.5.107	defun Construct an Or node . . . . .	278
8.5.108	defun Is this an Or node? . . . . .	278
8.5.109	defun Return the Left part of an Or node . . . . .	279
8.5.110	defun Return the Right part of an Or node . . . . .	279
8.5.111	defun Return the part of a parenthesised expression . . . . .	279
8.5.112	defun pfPretend . . . . .	279
8.5.113	defun Is this a Pretend node? . . . . .	280
8.5.114	defun Return the Expression part of a Pretend node . . . . .	280
8.5.115	defun Return the Type part of a Pretend node . . . . .	280
8.5.116	defun Construct a QualType node . . . . .	280
8.5.117	defun Construct a Restrict node . . . . .	281
8.5.118	defun Is this a Restrict node? . . . . .	281
8.5.119	defun Return the Expr part of a Restrict node . . . . .	281
8.5.120	defun Return the Type part of a Restrict node . . . . .	281
8.5.121	defun Construct a RetractTo node . . . . .	282
8.5.122	defun Construct a Return node . . . . .	282

8.5.123 defun Is this a Return node? . . . . .	282
8.5.124 defun Return the Expr part of a Return node . . . . .	282
8.5.125 defun pfReturnNoName . . . . .	283
8.5.126 defun Construct a ReturnTyped node . . . . .	283
8.5.127 defun Construct a Rule node . . . . .	283
8.5.128 defun Return the Lhs of a Rule node . . . . .	284
8.5.129 defun Return the Rhs of a Rule node . . . . .	284
8.5.130 defun Is this a Rule node? . . . . .	284
8.5.131 defun pfSecond . . . . .	284
8.5.132 defun Construct a Sequence node . . . . .	285
8.5.133 defun Return the Args of a Sequence node . . . . .	285
8.5.134 defun Is this a Sequence node? . . . . .	285
8.5.135 defun Return the parts of the Args of a Sequence node . . . . .	285
8.5.136 defun Create a Suchthat node . . . . .	286
8.5.137 defun Is this a SuchThat node? . . . . .	286
8.5.138 defun Return the Cond part of a SuchThat node . . . . .	286
8.5.139 defun Create a Tagged node . . . . .	286
8.5.140 defun Is this a Tagged node? . . . . .	287
8.5.141 defun Return the Expression portion of a Tagged node . . . . .	287
8.5.142 defun Return the Tag of a Tagged node . . . . .	287
8.5.143 defun pfTaggedToTyped . . . . .	287
8.5.144 defun pfTweakIf . . . . .	288
8.5.145 defun Construct a Typed node . . . . .	288
8.5.146 defun Is this a Typed node? . . . . .	289
8.5.147 defun Return the Type of a Typed node . . . . .	289
8.5.148 defun Return the Id of a Typed node . . . . .	289
8.5.149 defun Construct a Typing node . . . . .	289
8.5.150 defun Return a Tuple node . . . . .	290
8.5.151 defun Return a Tuple from a List . . . . .	290
8.5.152 defun Is this a Tuple node? . . . . .	290
8.5.153 defun Return the Parts of a Tuple node . . . . .	291
8.5.154 defun Return the parts of a Tuple . . . . .	291
8.5.155 defun Return a list from a Sequence node . . . . .	291
8.5.156 defun The comment is attached to all signatutres . . . . .	291
8.5.157 defun Construct a WDeclare node . . . . .	292
8.5.158 defun Construct a Where node . . . . .	292
8.5.159 defun Is this a Where node? . . . . .	292
8.5.160 defun Return the parts of the Context of a Where node . . . . .	293
8.5.161 defun Return the Context of a Where node . . . . .	293
8.5.162 defun Return the Expr part of a Where node . . . . .	293
8.5.163 defun Construct a While node . . . . .	293
8.5.164 defun Is this a While node? . . . . .	294
8.5.165 defun Return the Cond part of a While node . . . . .	294
8.5.166 defun Construct a With node . . . . .	294
8.5.167 defun Create a Wrong node . . . . .	294
8.5.168 defun Is this a Wrong node? . . . . .	295

<b>9 Pftree to s-expression translation</b>	<b>297</b>
9.0.169 defun Pftree to s-expression translation . . . . .	297
9.0.170 defun Pftree to s-expression translation inner function . . . . .	298
9.0.171 defun Convert a Literal to an S-expression . . . . .	302
9.0.172 defun Convert a float to an S-expression . . . . .	303
9.0.173 defun Change an Application node to an S-expression . . . . .	303
9.0.174 defun Convert a SuchThat node to an S-expression . . . . .	305
9.0.175 defun pfOp2Sex . . . . .	306
9.0.176 defun pmDontQuote? . . . . .	307
9.0.177 defun hasOptArgs? . . . . .	307
9.0.178 defun Convert a Sequence node to an S-expression . . . . .	308
9.0.179 defun pfSequence2Sex0 . . . . .	308
9.0.180 defun Convert a loop node to an S-expression . . . . .	309
9.0.181 defun Change a Collect node to an S-expression . . . . .	312
9.0.182 defun Convert a Definition node to an S-expression . . . . .	313
9.0.183 defun Convert a Lambda node to an S-expression . . . . .	314
9.0.184 defun pfCollectArgTran . . . . .	315
9.0.185 defun Convert a Lambda node to an S-expression . . . . .	315
9.0.186 defun Convert a Rule node to an S-expression . . . . .	316
9.0.187 defun Convert the Lhs of a Rule to an S-expression . . . . .	316
9.0.188 defun Convert the Rhs of a Rule to an S-expression . . . . .	317
9.0.189 defun Convert a Rule predicate to an S-expression . . . . .	317
9.0.190 defun patternVarsOf . . . . .	319
9.0.191 defun patternVarsOf1 . . . . .	319
9.0.192 defun pvarPredTran . . . . .	320
9.0.193 defun Convert the Lhs of a Rule node to an S-expression . . . . .	320
9.0.194 defvar \$dotdot . . . . .	321
9.0.195 defun Translate ops into internal symbols . . . . .	321
 <b>10 Keyed Message Handling</b>	 <b>323</b>
10.0.196 defvar \$cacheMessages . . . . .	324
10.0.197 defvar \$msgAlist . . . . .	324
10.0.198 defvar \$msgDatabaseName . . . . .	324
10.0.199 defvar \$testingErrorPrefix . . . . .	325
10.0.200 defvar \$texFormatting . . . . .	325
10.0.201 defvar \$*msghash* . . . . .	325
10.0.202 defvar \$msgdbPrims . . . . .	325
10.0.203 defvar \$msgdbPunct . . . . .	325
10.0.204 defvar \$msgdbNoBlanksBeforeGroup . . . . .	326
10.0.205 defvar \$msgdbNoBlanksAfterGroup . . . . .	326
10.0.206 defun Fetch a message from the message database . . . . .	326
10.0.207 defun Cache messages read from message database . . . . .	327
10.0.208 defun getKeyedMsg . . . . .	327
10.0.209 defun Say a message using a keyed lookup . . . . .	327
10.0.210 defun Handle msg formatting and print to file . . . . .	328
10.0.211 defun Break a message into words . . . . .	328

10.0.212	defun Write a msg into spadmsg.listing file . . . . .	329
10.0.213	defun sayMSG . . . . .	329
<b>11</b>	<b>Stream Utilities</b>	<b>331</b>
11.0.214	defun npNull . . . . .	331
11.0.215	defun StreamNull . . . . .	331
<b>12</b>	<b>Code Piles</b>	<b>333</b>
12.0.216	defun insertpile . . . . .	333
12.0.217	defun pilePlusComment . . . . .	334
12.0.218	defun pilePlusComments . . . . .	334
12.0.219	defun pileTree . . . . .	335
12.0.220	defun pileColumn . . . . .	335
12.0.221	defun pileForests . . . . .	335
12.0.222	defun pileForest . . . . .	336
12.0.223	defun pileForest1 . . . . .	336
12.0.224	defun eqpileTree . . . . .	337
12.0.225	defun pileCtree . . . . .	338
12.0.226	defun pileCforest . . . . .	338
12.0.227	defun enPile . . . . .	338
12.0.228	defun firstTokPosn . . . . .	339
12.0.229	defun lastTokPosn . . . . .	339
12.0.230	defun separatePiles . . . . .	339
<b>13</b>	<b>Dequeue Functions</b>	<b>341</b>
13.0.231	defun dqUnit . . . . .	341
13.0.232	defun dqConcat . . . . .	341
13.0.233	defun dqAppend . . . . .	342
13.0.234	defun dqToList . . . . .	342
<b>14</b>	<b>Message Handling</b>	<b>343</b>
14.1	The Line Object . . . . .	343
14.1.1	defun Line object creation . . . . .	343
14.1.2	defun Line element 0; Extra blanks . . . . .	343
14.1.3	defun Line element 1; String . . . . .	343
14.1.4	defun Line element 2; Globlal number . . . . .	344
14.1.5	defun Line element 2; Set Global number . . . . .	344
14.1.6	defun Line elemnt 3; Local number . . . . .	344
14.1.7	defun Line element 4; Place of origin . . . . .	344
14.1.8	defun Line element 4: Is it a filename? . . . . .	345
14.1.9	defun Line element 4: Is it a filename? . . . . .	345
14.1.10	defun Line element 4; Get filename . . . . .	345
14.2	Messages . . . . .	345
14.2.1	defun msgCreate . . . . .	345
14.2.2	defun getMsgPosTagOb . . . . .	346
14.2.3	defun getMsgKey . . . . .	346

14.2.4	defun getMsgArgL . . . . .	347
14.2.5	defun getMsgPrefix . . . . .	347
14.2.6	defun setMsgPrefix . . . . .	347
14.2.7	defun getMsgText . . . . .	347
14.2.8	defun setMsgText . . . . .	347
14.2.9	defun getMsgPrefix? . . . . .	348
14.2.10	defun getMsgTag . . . . .	348
14.2.11	defun getMsgTag? . . . . .	348
14.2.12	defun line? . . . . .	349
14.2.13	defun leader? . . . . .	349
14.2.14	defun toScreen? . . . . .	349
14.2.15	defun ncSoftError . . . . .	349
14.2.16	defun ncHardError . . . . .	350
14.2.17	defun desiredMsg . . . . .	350
14.2.18	defun processKeyedError . . . . .	351
14.2.19	defun msgOutputter . . . . .	351
14.2.20	defun listOutputter . . . . .	352
14.2.21	defun getStFromMsg . . . . .	352
14.2.22	defvar \$preLength . . . . .	353
14.2.23	defun getPreStL . . . . .	353
14.2.24	defun getPosStL . . . . .	354
14.2.25	defun ppos . . . . .	355
14.2.26	defun remFile . . . . .	355
14.2.27	defun showMsgPos? . . . . .	355
14.2.28	defvar \$imPrGuys . . . . .	356
14.2.29	defun msgImPr? . . . . .	356
14.2.30	defun getMsgCatAttr . . . . .	356
14.2.31	defun getMsgPos . . . . .	357
14.2.32	defun getMsgFTTag? . . . . .	357
14.2.33	defun decideHowMuch . . . . .	357
14.2.34	defun poNopos? . . . . .	358
14.2.35	defun poPosImmediate? . . . . .	358
14.2.36	defun poFileName . . . . .	358
14.2.37	defun poGetLineObject . . . . .	359
14.2.38	defun poLinePosn . . . . .	359
14.2.39	defun listDecideHowMuch . . . . .	359
14.2.40	defun remLine . . . . .	360
14.2.41	defun getMsgKey? . . . . .	360
14.2.42	defun getMsgLitSym . . . . .	360
14.2.43	defun tabbing . . . . .	360
14.2.44	defvar \$toWhereGuys . . . . .	361
14.2.45	defun getMsgToWhere . . . . .	361
14.2.46	defun toFile? . . . . .	361
14.2.47	defun alreadyOpened? . . . . .	361
14.2.48	defun setMsgForcedAttrList . . . . .	362
14.2.49	defun setMsgForcedAttr . . . . .	362



14.2.50 defvar \$attrCats . . . . .	362
14.2.51 defun whichCat . . . . .	363
14.2.52 defun setMsgCatlessAttr . . . . .	363
14.2.53 defun putDatabaseStuff . . . . .	363
14.2.54 defun getMsgInfoFromKey . . . . .	364
14.2.55 defun setMsgUnforcedAttrList . . . . .	364
14.2.56 defun setMsgUnforcedAttr . . . . .	365
14.2.57 defvar \$imPrTagGuys . . . . .	365
14.2.58 defun initImPr . . . . .	365
14.2.59 defun initToWhere . . . . .	366
14.2.60 defun ncBug . . . . .	366
14.2.61 defun processMsgList . . . . .	367
14.2.62 defun erMsgSort . . . . .	367
14.2.63 defun erMsgCompare . . . . .	368
14.2.64 defun compareposns . . . . .	368
14.2.65 defun erMsgSep . . . . .	368
14.2.66 defun makeMsgFromLine . . . . .	369
14.2.67 defun rep . . . . .	369
14.2.68 defun getLinePos . . . . .	370
14.2.69 defun getLineText . . . . .	370
14.2.70 defun queueUpErrors . . . . .	370
14.2.71 defun thisPosIsLess . . . . .	372
14.2.72 defun thisPosIsEqual . . . . .	372
14.2.73 defun redundant . . . . .	372
14.2.74 defvar \$repGuys . . . . .	373
14.2.75 defun msgNoRep? . . . . .	373
14.2.76 defun sameMsg? . . . . .	374
14.2.77 defun processChPosesForOneLine . . . . .	374
14.2.78 defun poCharPosn . . . . .	375
14.2.79 defun makeLeaderMsg . . . . .	375
14.2.80 defun posPointers . . . . .	376
14.2.81 defun getMsgPos2 . . . . .	376
14.2.82 defun insertPos . . . . .	377
14.2.83 defun putFTText . . . . .	377
14.2.84 defun From . . . . .	378
14.2.85 defun To . . . . .	378
14.2.86 defun FromTo . . . . .	378
<b>15 The Interpreter Syntax</b>	<b>381</b>
15.1 syntax assignment . . . . .	381
15.2 syntax blocks . . . . .	384
15.3 system clef . . . . .	386
15.4 syntax collection . . . . .	387
15.5 syntax for . . . . .	389
15.6 syntax if . . . . .	393
15.7 syntax iterate . . . . .	395

15.8 syntax leave . . . . .	396
15.9 syntax parallel . . . . .	397
15.10 syntax repeat . . . . .	400
15.11 syntax suchthat . . . . .	404
15.12 syntax syntax . . . . .	405
15.13 syntax while . . . . .	405
<b>16 Abstract Syntax Trees (ptrees)</b>	<b>409</b>
16.0.1 defun Construct a leaf token . . . . .	409
16.0.2 defun Return a part of a node . . . . .	410
16.0.3 defun Compare a part of a node . . . . .	410
16.0.4 defun pfNoPosition? . . . . .	410
16.0.5 defun poNoPosition? . . . . .	411
16.0.6 defun tokType . . . . .	411
16.0.7 defun tokPart . . . . .	411
16.0.8 defun tokPosn . . . . .	411
16.0.9 defun pfNoPosition . . . . .	412
16.0.10 defun poNoPosition . . . . .	412
<b>17 Attributed Structures</b>	<b>413</b>
17.0.11 defun ncTag . . . . .	413
17.0.12 defun ncAlist . . . . .	413
17.0.13 defun ncEltQ . . . . .	414
17.0.14 defun ncPutQ . . . . .	414
<b>18 Function Selection</b>	<b>417</b>
18.0.15 defun ofCategory . . . . .	417
18.0.16 defun isPartialMode . . . . .	418
18.0.17 defun hasCaty . . . . .	418
18.0.18 defun domArg . . . . .	420
18.0.19 defun domArg2 . . . . .	420
18.0.20 defun hasSig . . . . .	421
18.0.21 defun hasAtt . . . . .	422
18.0.22 defun hasSigAnd . . . . .	423
18.0.23 defun hasSigOr . . . . .	424
18.0.24 defun hasAttSig . . . . .	424
18.0.25 defun hasCate1 . . . . .	425
18.0.26 defun hasCatExpression . . . . .	425
18.0.27 defun unifyStruct . . . . .	426
18.0.28 defun unifyStructVar . . . . .	427
18.0.29 defun containsVars . . . . .	428
18.0.30 defun containsVars1 . . . . .	429
18.0.31 defun hasCaty1 . . . . .	429
18.0.32 defun mkDomPvar . . . . .	430
18.0.33 defun hasCate . . . . .	431
18.0.34 defun constructSubst . . . . .	432

18.0.35 defun hasCateSpecial . . . . .	432
18.0.36 defun hasCateSpecialNew . . . . .	433
18.0.37 defun defaultTargetFE . . . . .	435
18.0.38 defun isEqualOrSubDomain . . . . .	436
<b>19 System Command Handling</b>	<b>437</b>
19.1 Variables Used . . . . .	439
19.1.1 defvar \$systemCommands . . . . .	439
19.1.2 defvar \$syscommands . . . . .	440
19.1.3 defvar \$noParseCommands . . . . .	440
19.2 Functions . . . . .	441
19.2.1 defun handleNoParseCommands . . . . .	441
19.2.2 defun Handle a top level command . . . . .	442
19.2.3 defun Split block into option block . . . . .	443
19.2.4 defun Tokenize a system command . . . . .	443
19.2.5 defun Handle system commands . . . . .	444
19.2.6 defun Select commands matching this user level . . . . .	444
19.2.7 defun No command begins with this string . . . . .	445
19.2.8 defun No option begins with this string . . . . .	445
19.2.9 defvar \$oldline . . . . .	445
19.2.10 defun No command/option begins with this string . . . . .	445
19.2.11 defun Option not available at this user level . . . . .	446
19.2.12 defun Command not available at this user level . . . . .	446
19.2.13 defun Command not available error message . . . . .	446
19.2.14 defun satisfiesUserLevel . . . . .	447
19.2.15 defun hasOption . . . . .	447
19.2.16 defun terminateSystemCommand . . . . .	448
19.2.17 defun Terminate a system command . . . . .	448
19.2.18 defun commandAmbiguityError . . . . .	448
19.2.19 defun getParserMacroNames . . . . .	449
19.2.20 defun clearParserMacro . . . . .	449
19.2.21 defun displayMacro . . . . .	449
19.2.22 defun displayWorkspaceNames . . . . .	450
19.2.23 defun getWorkspaceNames . . . . .	451
19.2.24 defun fixObjectForPrinting . . . . .	452
19.2.25 defun displayProperties,sayFunctionDeps . . . . .	452
19.2.26 defun displayValue . . . . .	455
19.2.27 defun displayType . . . . .	456
19.2.28 defun getAndSay . . . . .	457
19.2.29 defun displayProperties . . . . .	457
19.2.30 defun displayParserMacro . . . . .	460
19.2.31 defun displayCondition . . . . .	461
19.2.32 defun interpFunctionDepAlists . . . . .	461
19.2.33 defun displayModemap . . . . .	462
19.2.34 defun displayMode . . . . .	462
19.2.35 defun Split into tokens delimited by spaces . . . . .	463

19.2.36 defun Convert string tokens to their proper type . . . . .	463
19.2.37 defun Is the argument string an integer? . . . . .	464
19.2.38 defun Handle parsed system commands . . . . .	464
19.2.39 defun Parse a system command . . . . .	465
19.2.40 defun Get first word in a string . . . . .	465
19.2.41 defun Unabbreviate keywords in commands . . . . .	465
19.2.42 defun The command is ambiguous error . . . . .	466
19.2.43 defun Remove the spaces surrounding a string . . . . .	467
19.2.44 defun Remove the lisp command prefix . . . . .	467
19.2.45 defun Handle the )lisp command . . . . .	468
19.2.46 defun The )boot command is no longer supported . . . . .	468
19.2.47 defun Handle the )system command . . . . .	468
19.2.48 defun Handle the )synonym command . . . . .	469
19.2.49 defun Handle the synonym system command . . . . .	469
19.2.50 defun printSynonyms . . . . .	470
19.2.51 defun Print a list of each matching synonym . . . . .	470
19.2.52 defvar \$tokenCommands . . . . .	471
19.2.53 defvar \$InitialCommandSynonymAlist . . . . .	472
19.2.54 defun Print the current version information . . . . .	472
19.2.55 defvar \$CommandSynonymAlist . . . . .	474
19.2.56 defun nclloopCommand . . . . .	474
19.2.57 defun nclloopPrefix? . . . . .	475
19.2.58 defun selectOptionLC . . . . .	475
19.2.59 defun selectOption . . . . .	475
<b>20 )abbreviations help page Command</b>	<b>477</b>
20.1 abbreviations help page man page . . . . .	477
20.2 Functions . . . . .	479
20.2.1 defun abbreviations . . . . .	479
20.2.2 defun abbreviationsSpad2Cmd . . . . .	479
20.2.3 defun listConstructorAbbreviations . . . . .	480
<b>21 )boot help page Command</b>	<b>483</b>
21.1 boot help page man page . . . . .	483
21.2 Functions . . . . .	484
<b>22 )browse help page Command</b>	<b>485</b>
22.1 browse help page man page . . . . .	485
22.2 Overview . . . . .	485
22.3 Browsers, MathML, and Fonts . . . . .	486
22.4 The axServer/multiServ loop . . . . .	487
22.5 The )browse command . . . . .	488
22.6 Variables Used . . . . .	489
22.7 Functions . . . . .	489
22.8 The server support code . . . . .	489

<b>23 )cd help page Command</b>	<b>491</b>
23.1 cd help page man page . . . . .	491
23.2 Variables Used . . . . .	492
23.3 Functions . . . . .	492
<b>24 )clear help page Command</b>	<b>493</b>
24.1 clear help page man page . . . . .	493
24.2 Variables Used . . . . .	495
24.2.1 defvar \$clearOptions . . . . .	495
24.3 Functions . . . . .	495
24.3.1 defun clear . . . . .	495
24.3.2 defvar \$clearExcept . . . . .	495
24.3.3 defun clearSpad2Cmd . . . . .	496
24.3.4 defun clearCmdSortedCaches . . . . .	497
24.3.5 defun compiledLookupCheck . . . . .	497
24.3.6 defvar \$functionTable . . . . .	498
24.3.7 defun clearCmdCompletely . . . . .	498
24.3.8 defun clearCmdAll . . . . .	499
24.3.9 defun clearMacroTable . . . . .	500
24.3.10 defun clearCmdExcept . . . . .	500
24.3.11 defun clearCmdParts . . . . .	501
<b>25 )close help page Command</b>	<b>505</b>
25.1 close help page man page . . . . .	505
25.2 Functions . . . . .	506
25.2.1 defun queryClients . . . . .	506
25.2.2 defun close . . . . .	506
<b>26 )compile help page Command</b>	<b>509</b>
26.1 compile help page man page . . . . .	509
26.2 Functions . . . . .	511
26.2.1 defvar \$/editfile . . . . .	511
<b>27 )copyright help page Command</b>	<b>513</b>
27.1 copyright help page man page . . . . .	513
27.2 Functions . . . . .	518
27.2.1 defun copyright . . . . .	518
27.2.2 defun trademark . . . . .	519
<b>28 )credits help page Command</b>	<b>521</b>
28.1 credits help page man page . . . . .	521
28.2 Variables Used . . . . .	521
28.3 Functions . . . . .	521
28.3.1 defun credits . . . . .	521

<b>29 )describe help page Command</b>	<b>523</b>
29.1 describe help page man page . . . . .	523
29.1.1 defvar \$describeOptions . . . . .	524
29.2 Functions . . . . .	524
29.2.1 defun Print comment strings from algebra libraries . . . . .	524
29.2.2 defun describeSpad2Cmd . . . . .	524
29.2.3 defun cleanline . . . . .	525
29.2.4 defun flatten . . . . .	527
<b>30 )display help page Command</b>	<b>529</b>
30.1 display help page man page . . . . .	529
30.1.1 defvar \$displayOptions . . . . .	531
30.2 Functions . . . . .	531
30.2.1 defun display . . . . .	531
30.2.2 displaySpad2Cmd . . . . .	531
30.2.3 defun abbQuery . . . . .	532
30.2.4 defun displayOperations . . . . .	533
30.2.5 defun yesanswer . . . . .	533
30.2.6 defun displayMacros . . . . .	534
30.2.7 defun sayExample . . . . .	535
30.2.8 defun cleanupLine . . . . .	536
<b>31 )edit help page Command</b>	<b>539</b>
31.1 edit help page man page . . . . .	539
31.2 Functions . . . . .	540
31.2.1 defun edit . . . . .	540
31.2.2 defun editSpad2Cmd . . . . .	540
31.2.3 defun Implement the )edit command . . . . .	541
31.2.4 defun updateSourceFiles . . . . .	542
<b>32 )fin help page Command</b>	<b>543</b>
32.1 fin help page man page . . . . .	543
32.1.1 defun Exit from the interpreter to lisp . . . . .	544
32.2 Functions . . . . .	544
<b>33 )frame help page Command</b>	<b>545</b>
33.1 frame help page man page . . . . .	545
33.2 Variables Used . . . . .	547
33.2.1 Primary variables . . . . .	547
33.2.2 Used variables . . . . .	548
33.3 Data Structures . . . . .	548
33.3.1 Frames and the Interpreter Frame Ring . . . . .	548
33.4 Accessor Functions . . . . .	548
33.4.1 0th Frame Component – frameName . . . . .	548
33.4.2 defun frameName . . . . .	548
33.4.3 1st Frame Component – frameInteractive . . . . .	549

33.4.4	2nd Frame Component – frameIOIndex . . . . .	549
33.4.5	3rd Frame Component – frameHiFiAccess . . . . .	549
33.4.6	4th Frame Component – frameHistList . . . . .	549
33.4.7	5th Frame Component – frameHistListLen . . . . .	550
33.4.8	6th Frame Component – frameHistListAct . . . . .	550
33.4.9	7th Frame Component – frameHistRecord . . . . .	550
33.4.10	8th Frame Component – frameHistoryTable . . . . .	550
33.4.11	9th Frame Component – frameExposureData . . . . .	551
33.5	Functions . . . . .	551
33.5.1	Initializing the Interpreter Frame Ring . . . . .	551
33.5.2	Creating a List of all of the Frame Names . . . . .	552
33.5.3	Get Named Frame Environment (aka Interactive) . . . . .	552
33.5.4	Create a new, empty Interpreter Frame . . . . .	552
33.5.5	Collecting up the Environment into a Frame . . . . .	553
33.5.6	Update from the Current Frame . . . . .	554
33.5.7	Find a Frame in the Frame Ring by Name . . . . .	555
33.5.8	Update the Current Interpreter Frame . . . . .	555
33.5.9	Move to the next Interpreter Frame in Ring . . . . .	556
33.5.10	Change to the Named Interpreter Frame . . . . .	556
33.5.11	Move to the previous Interpreter Frame in Ring . . . . .	557
33.5.12	Add a New Interpreter Frame . . . . .	557
33.5.13	Close an Interpreter Frame . . . . .	558
33.5.14	Display the Frame Names . . . . .	559
33.5.15	Import items from another frame . . . . .	559
33.5.16	The top level frame command . . . . .	561
33.5.17	The top level frame command handler . . . . .	562
33.6	Frame File Messages . . . . .	563
<b>34</b>	<b>)help help page Command</b>	<b>565</b>
34.1	help help page man page . . . . .	565
34.2	Functions . . . . .	568
34.2.1	The top level help command . . . . .	568
34.2.2	The top level help command handler . . . . .	568
34.2.3	defun newHelpSpad2Cmd . . . . .	568
<b>35</b>	<b>)history help page Command</b>	<b>571</b>
35.1	history help page man page . . . . .	571
35.2	Initialized history variables . . . . .	574
35.2.1	defvar \$oldHistoryFileName . . . . .	574
35.2.2	defvar \$historyFileType . . . . .	575
35.2.3	defvar \$historyDirectory . . . . .	575
35.2.4	defvar \$useInternalHistoryTable . . . . .	575
35.3	Data Structures . . . . .	575
35.4	Functions . . . . .	575
35.4.1	defun makeHistFileName . . . . .	575
35.4.2	defun oldHistFileName . . . . .	576

35.4.3	defun histFileName . . . . .	576
35.4.4	defun histInputFileName . . . . .	576
35.4.5	defun initHist . . . . .	577
35.4.6	defun initHistList . . . . .	577
35.4.7	The top level history command . . . . .	578
35.4.8	The top level history command handler . . . . .	578
35.4.9	defun setHistoryCore . . . . .	580
35.4.10	defvar \$sunderbar . . . . .	582
35.4.11	defun writeInputLines . . . . .	583
35.4.12	defun resetInCoreHist . . . . .	584
35.4.13	defun changeHistListLen . . . . .	585
35.4.14	defun updateHist . . . . .	585
35.4.15	defun updateInCoreHist . . . . .	586
35.4.16	defun putHist . . . . .	586
35.4.17	defun recordNewValue . . . . .	587
35.4.18	defun recordNewValue0 . . . . .	587
35.4.19	defun recordOldValue . . . . .	588
35.4.20	defun recordOldValue0 . . . . .	588
35.4.21	defun undoInCore . . . . .	588
35.4.22	defun undoChanges . . . . .	589
35.4.23	defun undoFromFile . . . . .	590
35.4.24	defun saveHistory . . . . .	591
35.4.25	defun restoreHistory . . . . .	593
35.4.26	defun setIOindex . . . . .	595
35.4.27	defun showInput . . . . .	595
35.4.28	defun showInOut . . . . .	596
35.4.29	defun fetchOutput . . . . .	596
35.4.30	Read the history file using index n . . . . .	597
35.4.31	Write information of the current step to history file . . . . .	598
35.4.32	Disable history if an error occurred . . . . .	599
35.4.33	defun writeHistModesAndValues . . . . .	599
35.5	Lisplib output transformations . . . . .	600
35.5.1	defun spadwrite0 . . . . .	600
35.5.2	defun Random write to a stream . . . . .	600
35.5.3	defun spadwrite . . . . .	601
35.5.4	defun spadread . . . . .	601
35.5.5	defun Random read a key from a stream . . . . .	601
35.5.6	defun unwritable? . . . . .	602
35.5.7	defun writifyComplain . . . . .	602
35.5.8	defun safeWritify . . . . .	602
35.5.9	defun writify,writifyInner . . . . .	603
35.5.10	defun writify . . . . .	606
35.5.11	defun spadClosure? . . . . .	607
35.5.12	defvar \$NonNullStream . . . . .	607
35.5.13	defvar \$NullStream . . . . .	607
35.5.14	defun dewritify,dewritifyInner . . . . .	608



35.5.15 defun dewritify . . . . .	611
35.5.16 defun ScanOrPairVec,ScanOrInner . . . . .	611
35.5.17 defun ScanOrPairVec . . . . .	612
35.5.18 defun gensymInt . . . . .	612
35.5.19 defun charDigitVal . . . . .	613
35.5.20 defun histFileErase . . . . .	613
35.6 History File Messages . . . . .	614
<b>36 )include help page Command</b>	<b>617</b>
36.1 include help page man page . . . . .	617
36.2 Functions . . . . .	617
36.2.1 defun nloopInclude1 . . . . .	617
36.2.2 Returns the first non-blank substring of the given string . . . . .	618
36.2.3 Open the include file and read it in . . . . .	618
36.2.4 Return the include filename . . . . .	618
36.2.5 Return the next token . . . . .	619
<b>37 )library help page Command</b>	<b>621</b>
37.1 library help page man page . . . . .	621
<b>38 )lisp help page Command</b>	<b>623</b>
38.1 lisp help page man page . . . . .	623
38.2 Functions . . . . .	624
<b>39 )load help page Command</b>	<b>625</b>
39.1 load help page man page . . . . .	625
39.1.1 defun The )load command (obsolete) . . . . .	625
<b>40 )ltrace help page Command</b>	<b>627</b>
40.1 ltrace help page man page . . . . .	627
40.1.1 defun The top level )ltrace function . . . . .	628
40.2 Variables Used . . . . .	628
40.3 Functions . . . . .	628
<b>41 )pquit help page Command</b>	<b>629</b>
41.1 pquit help page man page . . . . .	629
41.2 Functions . . . . .	630
41.2.1 The top level pquit command . . . . .	630
41.2.2 The top level pquit command handler . . . . .	630
<b>42 )quit help page Command</b>	<b>633</b>
42.1 quit help page man page . . . . .	633
42.2 Functions . . . . .	634
42.2.1 The top level quit command . . . . .	634
42.2.2 The top level quit command handler . . . . .	634
42.2.3 Leave the Axiom interpreter . . . . .	635

<b>43 )read help page Command</b>	<b>637</b>
43.1 read help page man page . . . . .	637
43.1.1 defun The )read command . . . . .	638
43.1.2 defun Implement the )read command . . . . .	638
43.1.3 defun /read . . . . .	640
<b>44 )savesystem help page Command</b>	<b>641</b>
44.1 savesystem help page man page . . . . .	641
44.1.1 defun The )savesystem command . . . . .	642
<b>45 )set help page Command</b>	<b>643</b>
45.1 set help page man page . . . . .	643
45.2 Overview . . . . .	644
45.3 Variables Used . . . . .	645
45.4 Functions . . . . .	645
45.4.1 Initialize the set variables . . . . .	645
45.4.2 Reset the workspace variables . . . . .	646
45.4.3 Display the set option information . . . . .	647
45.4.4 Display the set variable settings . . . . .	649
45.4.5 Translate options values to t or nil . . . . .	650
45.4.6 Translate t or nil to option values . . . . .	651
45.5 The list structure . . . . .	651
45.6 breakmode . . . . .	652
45.6.1 defvar \$BreakMode . . . . .	653
45.7 debug . . . . .	653
45.8 debug lambda type . . . . .	654
45.8.1 defvar \$lambdatype . . . . .	654
45.9 debug dalymode . . . . .	654
45.9.1 defvar \$dalymode . . . . .	655
45.10 compile . . . . .	655
45.11 compile output . . . . .	656
45.12 Variables Used . . . . .	656
45.13 Functions . . . . .	656
45.13.1 The set output command handler . . . . .	656
45.13.2 Describe the set output library arguments . . . . .	657
45.13.3 defvar \$output-library . . . . .	657
45.13.4 Open the output library . . . . .	658
45.14 compile input . . . . .	658
45.15 Variables Used . . . . .	659
45.16 Functions . . . . .	659
45.16.1 The set input library command handler . . . . .	659
45.16.2 Describe the set input library arguments . . . . .	660
45.16.3 Add the input library to the list . . . . .	660
45.16.4 defvar \$input-libraries . . . . .	660
45.16.5 Drop an input library from the list . . . . .	661
45.17 expose . . . . .	661

45.18	Variables Used	662
45.18.1	defvar \$globalExposureGroupAlist	662
45.18.2	defvar \$localExposureDataDefault	688
45.18.3	defvar \$localExposureData	688
45.19	Functions	688
45.19.1	The top level set expose command handler	688
45.19.2	The top level set expose add command handler	689
45.19.3	Expose a group	690
45.19.4	The top level set expose add constructor handler	692
45.19.5	The top level set expose drop handler	693
45.19.6	The top level set expose drop group handler	694
45.19.7	The top level set expose drop constructor handler	695
45.19.8	Display exposed groups	696
45.19.9	Display exposed constructors	696
45.19.10	Display hidden constructors	697
45.20	functions	697
45.21	functions cache	698
45.22	Variables Used	699
45.22.1	defvar \$cacheAlist	699
45.23	Functions	699
45.23.1	The top level set functions cache handler	699
45.23.2	defvar \$compileDontDefineFunctions	703
45.24	functions recurrence	703
45.24.1	defvar \$compileRecurrence	704
45.25	fortran	704
45.25.1	ints2floats	705
45.25.2	defvar \$fortInts2Floats	706
45.25.3	fortindent	706
45.25.4	defvar \$fortIndent	706
45.25.5	fortlength	707
45.25.6	defvar \$fortLength	707
45.25.7	typedecs	707
45.25.8	defvar \$printFortranDecs	708
45.25.9	defaulttype	708
45.25.10	defvar \$defaultFortranType	709
45.25.11	precision	709
45.25.12	defvar \$fortranPrecision	709
45.25.13	intrinsic	710
45.25.14	defvar \$useIntrinsicFunctions	710
45.25.15	explength	711
45.25.16	defvar \$maximumFortranExpressionLength	711
45.25.17	segment	711
45.25.18	defvar \$fortranSegment	712
45.25.19	optlevel	712
45.25.20	defvar \$fortranOptimizationLevel	712
45.25.21	startindex	713

45.25.22	defvar \$fortranArrayStartingIndex . . . . .	713
45.25.23	calling . . . . .	713
45.25.24	defvar \$fortranTmpDir . . . . .	714
45.25.25	The top level set fortran calling tempfile handler . . . . .	715
45.25.26	Validate the output directory . . . . .	716
45.25.27	Describe the set fortran calling tempfile . . . . .	716
45.25.28	defvar \$fortranDirectory . . . . .	717
45.25.29	defun setFortDir . . . . .	717
45.25.30	defun describeSetFortDir . . . . .	718
45.25.31	defvar \$fortranLibraries . . . . .	719
45.25.32	defun setLinkerArgs . . . . .	720
45.25.33	defun describeSetLinkerArgs . . . . .	720
45.26	hyperdoc . . . . .	721
45.26.1	fullscreen . . . . .	721
45.26.2	defvar \$fullScreenSysVars . . . . .	721
45.26.3	mathwidth . . . . .	722
45.26.4	defvar \$historyDisplayWidth . . . . .	722
45.27	help . . . . .	723
45.27.1	fullscreen . . . . .	723
45.27.2	defvar \$useFullScreenHelp . . . . .	723
45.28	history . . . . .	724
45.28.1	defvar \$HiFiAccess . . . . .	724
45.29	messages . . . . .	725
45.29.1	any . . . . .	726
45.29.2	defvar \$printAnyIfTrue . . . . .	726
45.29.3	autoload . . . . .	727
45.29.4	defvar \$printLoadMsgs . . . . .	727
45.29.5	bottomup . . . . .	728
45.29.6	defvar \$reportBottomUpFlag . . . . .	728
45.29.7	coercion . . . . .	728
45.29.8	defvar \$reportCoerceIfTrue . . . . .	729
45.29.9	dropmap . . . . .	729
45.29.10	defvar \$displayDroppedMap . . . . .	730
45.29.11	expose . . . . .	730
45.29.12	defvar \$giveExposureWarning . . . . .	730
45.29.13	file . . . . .	731
45.29.14	defvar \$printMsgsToFile . . . . .	731
45.29.15	frame . . . . .	732
45.29.16	defvar \$frameMessages . . . . .	732
45.29.17	highlighting . . . . .	732
45.29.18	defvar \$highlightAllowed . . . . .	733
45.29.19	instant . . . . .	733
45.29.20	defvar \$reportInstantiations . . . . .	734
45.29.21	insteach . . . . .	734
45.29.22	defvar \$reportEachInstantiation— . . . . .	734
45.29.23	interponly . . . . .	735

45.29.24	defvar \$reportInterpOnly . . . . .	735
45.29.25	naglink . . . . .	736
45.29.26	defvar \$nagMessages . . . . .	736
45.29.27	number . . . . .	736
45.29.28	defvar \$displayMsgNumber . . . . .	737
45.29.29	prompt . . . . .	737
45.29.30	defvar \$inputPromptType . . . . .	738
45.29.31	election . . . . .	738
45.29.32	set . . . . .	739
45.29.33	defvar \$displaySetValue . . . . .	739
45.29.34	startup . . . . .	740
45.29.35	defvar \$displayStartMsgs . . . . .	740
45.29.36	summary . . . . .	740
45.29.37	defvar \$printStatisticsSummaryIfTrue . . . . .	741
45.29.38	testing . . . . .	741
45.29.39	defvar \$testingSystem . . . . .	742
45.29.40	time . . . . .	742
45.29.41	defvar \$printTimeIfTrue . . . . .	742
45.29.42	type . . . . .	743
45.29.43	defvar \$printTypeIfTrue . . . . .	743
45.29.44	void . . . . .	744
45.29.45	defvar \$printVoidIfTrue . . . . .	744
45.30	naglink . . . . .	744
45.30.1	host . . . . .	745
45.30.2	defvar \$nagHost . . . . .	745
45.30.3	defun setNagHost . . . . .	746
45.30.4	defun describeSetNagHost . . . . .	746
45.30.5	persistence . . . . .	747
45.30.6	defvar \$fortPersistence . . . . .	747
45.30.7	defun setFortPers . . . . .	748
45.30.8	defun describeFortPersistence . . . . .	748
45.30.9	messages . . . . .	749
45.30.10	double . . . . .	749
45.30.11	defvar \$nagEnforceDouble . . . . .	750
45.31	output . . . . .	750
45.31.1	abbreviate . . . . .	751
45.31.2	defvar \$abbreviateTypes . . . . .	752
45.31.3	algebra . . . . .	752
45.31.4	defvar \$algebraFormat . . . . .	753
45.31.5	defvar \$algebraOutputFile . . . . .	753
45.31.6	defvar \$algebraOutputStream . . . . .	754
45.31.7	defun setOutputAlgebra . . . . .	754
45.31.8	defun describeSetOutputAlgebra . . . . .	756
45.31.9	characters . . . . .	757
45.31.10	defun setOutputCharacters . . . . .	758
45.31.11	fortran . . . . .	759

45.31.12	defvar \$fortranFormat . . . . .	760
45.31.13	defvar \$fortranOutputFile . . . . .	760
45.31.14	defun setOutputFortran . . . . .	761
45.31.15	defun describeSetOutputFortran . . . . .	763
45.31.16	fraction . . . . .	764
45.31.17	defvar \$fractionDisplayType . . . . .	765
45.31.18	length . . . . .	765
45.31.19	defvar \$margin . . . . .	765
45.31.20	defvar \$linelength . . . . .	765
45.31.21	mathml . . . . .	766
45.31.22	defvar \$mathmlFormat . . . . .	767
45.31.23	defvar \$mathmlOutputFile . . . . .	767
45.31.24	defun setOutputMathml . . . . .	768
45.31.25	defun describeSetOutputMathml . . . . .	770
45.31.26	html . . . . .	771
45.31.27	defvar \$htmlFormat . . . . .	771
45.31.28	defvar \$htmlOutputFile . . . . .	771
45.31.29	defun setOutputHtml . . . . .	772
45.31.30	defun describeSetOutputHtml . . . . .	774
45.31.31	openmath . . . . .	775
45.31.32	defvar \$openMathFormat . . . . .	776
45.31.33	defvar \$openMathOutputFile . . . . .	776
45.31.34	defun setOutputOpenMath . . . . .	777
45.31.35	defun describeSetOutputOpenMath . . . . .	779
45.31.36	script . . . . .	780
45.31.37	defvar \$formulaFormat . . . . .	781
45.31.38	defvar \$formulaOutputFile . . . . .	781
45.31.39	defun setOutputFormula . . . . .	781
45.31.40	defun describeSetOutputFormula . . . . .	784
45.31.41	scripts . . . . .	784
45.31.42	defvar \$linearFormatScripts . . . . .	785
45.31.43	showeditor . . . . .	785
45.31.44	defvar \$useEditorForShowOutput . . . . .	786
45.31.45	tex . . . . .	786
45.31.46	defvar \$texFormat . . . . .	787
45.31.47	defvar \$texOutputFile . . . . .	787
45.31.48	defun setOutputTex . . . . .	788
45.31.49	defun describeSetOutputTex . . . . .	790
45.32	quit . . . . .	791
45.32.1	defvar \$quitCommandType . . . . .	791
45.33	streams . . . . .	791
45.33.1	calculate . . . . .	792
45.33.2	defvar \$streamCount . . . . .	792
45.33.3	defun setStreamsCalculate . . . . .	793
45.33.4	defun describeSetStreamsCalculate . . . . .	793
45.33.5	showall . . . . .	794

45.33.6 defvar \$streamsShowAll . . . . .	794
45.34 system . . . . .	795
45.34.1 functioncode . . . . .	795
45.34.2 defvar \$reportCompilation . . . . .	795
45.34.3 optimization . . . . .	796
45.34.4 defvar \$reportOptimization . . . . .	796
45.34.5 prettyprint . . . . .	797
45.34.6 defvar \$prettyprint . . . . .	797
45.35 userlevel . . . . .	798
45.35.1 defvar \$UserLevel . . . . .	798
45.35.2 defvar \$setOptionNames . . . . .	799
45.36 Set code . . . . .	799
45.36.1 defun set . . . . .	799
45.36.2 defun set1 . . . . .	800
<b>46 )show help page Command</b>	<b>805</b>
46.1 show help page man page . . . . .	805
46.1.1 defun The )show command . . . . .	806
46.1.2 defun The internal )show command . . . . .	806
46.1.3 defun reportOperations . . . . .	807
46.1.4 defun reportOpsFromLisplib0 . . . . .	809
46.1.5 defun reportOpsFromLisplib1 . . . . .	809
46.1.6 defun reportOpsFromLisplib . . . . .	810
46.1.7 defun isExposedConstructor . . . . .	812
46.1.8 defun displayOperationsFromLisplib . . . . .	812
46.1.9 defun reportOpsFromUnitDirectly0 . . . . .	813
46.1.10 defun reportOpsFromUnitDirectly . . . . .	813
46.1.11 defun getOplistForConstructorForm . . . . .	816
46.1.12 defun getOplistWithUniqueSignatures . . . . .	817
46.1.13 defun reportOpsFromUnitDirectly1 . . . . .	817
46.1.14 defun sayShowWarning . . . . .	818
<b>47 )spool help page Command</b>	<b>819</b>
47.1 spool help page man page . . . . .	819
<b>48 )summary help page Command</b>	<b>821</b>
48.1 summary help page man page . . . . .	821
48.1.1 defun summary . . . . .	822
<b>49 )synonym help page Command</b>	<b>823</b>
49.1 synonym help page man page . . . . .	823
49.1.1 defun The )synonym command . . . . .	824
49.1.2 defun The )synonym command implementation . . . . .	824
49.1.3 defun Return a sublist of applicable synonyms . . . . .	825
49.1.4 defun Get the system command from the input line . . . . .	825
49.1.5 defun Remove system keyword . . . . .	826

49.1.6 defun processSynonymLine . . . . .	827
<b>50 )system help page Command</b>	<b>829</b>
50.1 system help page man page . . . . .	829
<b>51 )trace help page Command</b>	<b>831</b>
51.1 trace help page man page . . . . .	831
51.1.1 The trace global variables . . . . .	835
51.1.2 defvar \$traceNoisely . . . . .	836
51.1.3 defvar \$reportSpadTrace . . . . .	836
51.1.4 defvar \$optionAlist . . . . .	836
51.1.5 defvar \$tracedMapSignatures . . . . .	836
51.1.6 defvar \$traceOptionList . . . . .	836
51.1.7 defun trace . . . . .	837
51.1.8 defun traceSpad2Cmd . . . . .	837
51.1.9 defun trace1 . . . . .	838
51.1.10 defun getTraceOptions . . . . .	842
51.1.11 defun saveMapSig . . . . .	843
51.1.12 defun getMapSig . . . . .	843
51.1.13 defun getTraceOption,hn . . . . .	843
51.1.14 defun getTraceOption . . . . .	844
51.1.15 defun traceOptionError . . . . .	847
51.1.16 defun resetTimers . . . . .	848
51.1.17 defun resetSpacers . . . . .	848
51.1.18 defun resetCounters . . . . .	848
51.1.19 defun ptimers . . . . .	849
51.1.20 defun pspacers . . . . .	849
51.1.21 defun pcounters . . . . .	850
51.1.22 defun transOnlyOption . . . . .	850
51.1.23 defun stackTraceOptionError . . . . .	851
51.1.24 defun removeOption . . . . .	851
51.1.25 defun domainToGenvar . . . . .	851
51.1.26 defun genDomainTraceName . . . . .	852
51.1.27 defun untrace . . . . .	852
51.1.28 defun transTraceItem . . . . .	853
51.1.29 defun removeTracedMapSigs . . . . .	854
51.1.30 defun coerceTraceArgs2E . . . . .	854
51.1.31 defun coerceSpadArgs2E . . . . .	855
51.1.32 defun subTypes . . . . .	856
51.1.33 defun coerceTraceFunValue2E . . . . .	857
51.1.34 defun coerceSpadFunValue2E . . . . .	858
51.1.35 defun isListOfIdentifiers . . . . .	858
51.1.36 defun isListOfIdentifiersOrStrings . . . . .	859
51.1.37 defun getMapSubNames . . . . .	859
51.1.38 defun getPreviousMapSubNames . . . . .	860
51.1.39 defun lassocSub . . . . .	861



51.1.40 defun rassocSub . . . . .	861
51.1.41 defun isUncompiledMap . . . . .	861
51.1.42 defun isInterpOnlyMap . . . . .	862
51.1.43 defun augmentTraceNames . . . . .	862
51.1.44 defun isSubForRedundantMapName . . . . .	863
51.1.45 defun untraceMapSubNames . . . . .	863
51.1.46 defun funfind,LAM . . . . .	864
51.1.47 defmacro funfind . . . . .	864
51.1.48 defun isDomainOrPackage . . . . .	865
51.1.49 defun isTraceGensym . . . . .	865
51.1.50 defun spadTrace,g . . . . .	865
51.1.51 defun spadTrace,isTraceable . . . . .	865
51.1.52 defun spadTrace . . . . .	866
51.1.53 defun traceDomainLocalOps . . . . .	870
51.1.54 defun untraceDomainLocalOps . . . . .	870
51.1.55 defun traceDomainConstructor . . . . .	870
51.1.56 defun untraceDomainConstructor,keepTraced? . . . . .	872
51.1.57 defun untraceDomainConstructor . . . . .	873
51.1.58 defun flattenOperationAlist . . . . .	873
51.1.59 defun mapLetPrint . . . . .	874
51.1.60 defun letPrint . . . . .	875
51.1.61 defun Identifier beginning with a sharpsign-number? . . . . .	876
51.1.62 defun Identifier beginning with a sharpsign? . . . . .	876
51.1.63 defun isgenvar . . . . .	876
51.1.64 defun letPrint2 . . . . .	877
51.1.65 defun letPrint3 . . . . .	878
51.1.66 defun getAliasIfTracedMapParameter . . . . .	879
51.1.67 defun getBpiNameIfTracedMap . . . . .	880
51.1.68 defun hasPair . . . . .	881
51.1.69 defun shortenForPrinting . . . . .	881
51.1.70 defun spadTraceAlias . . . . .	881
51.1.71 defun getOption . . . . .	882
51.1.72 defun reportSpadTrace . . . . .	882
51.1.73 defun orderBySlotNumber . . . . .	883
51.1.74 defun /tracereply . . . . .	884
51.1.75 defun spadReply,printName . . . . .	884
51.1.76 defun spadReply . . . . .	885
51.1.77 defun spadUntrace . . . . .	885
51.1.78 defun remover . . . . .	887
51.1.79 defun prTraceNames,fn . . . . .	888
51.1.80 defun prTraceNames . . . . .	888
51.1.81 defvar \$constructors . . . . .	889
51.1.82 defun traceReply . . . . .	889
51.1.83 defun addTraceItem . . . . .	892
51.1.84 defun ?t . . . . .	892
51.1.85 defun tracelet . . . . .	894

51.1.86 defun breaklet . . . . .	895
51.1.87 defun stupidIsSpadFunction . . . . .	896
51.1.88 defun break . . . . .	896
51.1.89 defun compileBoot . . . . .	897
<b>52 )undo help page Command</b>	<b>899</b>
52.1 undo help page man page . . . . .	899
52.2 Evaluation . . . . .	900
52.2.1 defun evalDomain . . . . .	903
52.2.2 defun mkEvalable . . . . .	903
52.2.3 defun mkEvalableUnion . . . . .	905
52.2.4 defun mkEvalableRecord . . . . .	905
52.2.5 defun mkEvalableMapping . . . . .	905
52.2.6 defun evaluateType . . . . .	906
52.2.7 defun Eval args passed to a constructor . . . . .	907
52.2.8 defvar \$noEvalTypeMsg . . . . .	909
52.2.9 defun throwEvalTypeMsg . . . . .	909
52.2.10 defun makeOrdinal . . . . .	910
52.2.11 defun evaluateSignature . . . . .	910
52.3 Data Structures . . . . .	910
52.4 Functions . . . . .	911
52.4.1 Initial Undo Variables . . . . .	911
52.4.2 defvar \$undoFlag . . . . .	911
52.4.3 defvar \$frameRecord . . . . .	911
52.4.4 defvar \$previousBindings . . . . .	911
52.4.5 defvar \$reportUndo . . . . .	912
52.4.6 defun undo . . . . .	912
52.4.7 defun recordFrame . . . . .	913
52.4.8 defun diffAlist . . . . .	914
52.4.9 defun reportUndo . . . . .	917
52.4.10 defun clearFrame . . . . .	919
52.4.11 Undo previous n commands . . . . .	919
52.4.12 defun undoSteps . . . . .	920
52.4.13 defun undoSingleStep . . . . .	921
52.4.14 defun undoLocalModemapHack . . . . .	923
52.4.15 Remove undo lines from history write . . . . .	923
<b>53 )what help page Command</b>	<b>927</b>
53.1 what help page man page . . . . .	927
53.1.1 defvar \$whatOptions . . . . .	929
53.1.2 defun what . . . . .	929
53.1.3 defun whatSpad2Cmd,fixpat . . . . .	929
53.1.4 defun whatSpad2Cmd . . . . .	930
53.1.5 defun Show keywords for )what command . . . . .	931
53.1.6 defun The )what commands implementation . . . . .	931
53.1.7 defun Find all names contained in a pattern . . . . .	932

53.1.8 defun Find function of names contained in pattern . . . . .	933
53.1.9 defun satisfiesRegularExpressions . . . . .	933
53.1.10 defun filterAndFormatConstructors . . . . .	934
53.1.11 defun whatConstructors . . . . .	935
53.1.12 Display all operation names containing the fragment . . . . .	935
<b>54 )with help page Command</b>	<b>937</b>
54.1 with help page man page . . . . .	937
54.1.1 defun with . . . . .	937
<b>55 )workfiles help page Command</b>	<b>939</b>
55.1 workfiles help page man page . . . . .	939
55.1.1 defun workfiles . . . . .	939
55.1.2 defun workfilesSpad2Cmd . . . . .	939
<b>56 )zsystemdevelopment help page Command</b>	<b>943</b>
56.1 zsystemdevelopment help page man page . . . . .	943
56.1.1 defun zsystemdevelopment . . . . .	943
56.1.2 defun zsystemDevelopmentSpad2Cmd . . . . .	943
56.1.3 defun zsystemdevelopment1 . . . . .	944
<b>57 Handlers for Special Forms</b>	<b>947</b>
57.0.4 defun getAndEvalConstructorArgument . . . . .	948
57.0.5 defun replaceSharps . . . . .	948
57.0.6 defun isDomainValuedVariable . . . . .	949
57.0.7 defun evalCategory . . . . .	949
<b>58 Handling input files</b>	<b>951</b>
58.0.8 defun Handle .axiom.input file . . . . .	951
58.0.9 defvar \$boot-line-stack . . . . .	951
58.0.10 defvar \$in-stream . . . . .	951
58.0.11 defvar \$out-stream . . . . .	952
58.0.12 defvar \$file-closed . . . . .	952
58.0.13 defvar \$echo-meta . . . . .	952
58.0.14 defvar \$noSubsumption . . . . .	952
58.0.15 defvar \$envHashTable . . . . .	953
58.0.16 defun Dynamically add bindings to the environment . . . . .	953
58.0.17 defun Fetch a property list for a symbol from CategoryFrame . . . . .	954
58.0.18 defun Search for a binding in the environment list . . . . .	954
58.0.19 defun Search for a binding in the current environment . . . . .	954
58.0.20 defun searchTailEnv . . . . .	955
<b>59 File Parsing</b>	<b>957</b>
59.0.21 defun Bind a variable in the interactive environment . . . . .	957
59.0.22 defvar \$line-handler . . . . .	957
59.0.23 defvar \$spad-errors . . . . .	957

59.0.24 defvar \$xtokenreader . . . . .	958
59.0.25 defun Initialize the spad reader . . . . .	958
59.0.26 defun spad-syntax-error . . . . .	959
59.0.27 defun spad-long-error . . . . .	959
59.0.28 defun spad-short-error . . . . .	960
59.0.29 defun spad-error-loc . . . . .	960
59.0.30 defun iostat . . . . .	960
59.0.31 defun next-lines-show . . . . .	961
59.0.32 defun token-stack-show . . . . .	961
59.0.33 defun ioclear . . . . .	962
59.0.34 defun Set boot-line-stack to nil . . . . .	962
<b>60 Handling output</b>	<b>965</b>
60.1 Special Character Tables . . . . .	965
60.1.1 defvar \$defaultSpecialCharacters . . . . .	965
60.1.2 defvar \$plainSpecialCharacters0 . . . . .	966
60.1.3 defvar \$plainSpecialCharacters1 . . . . .	966
60.1.4 defvar \$plainSpecialCharacters2 . . . . .	967
60.1.5 defvar \$plainSpecialCharacters3 . . . . .	967
60.1.6 defvar \$plainRTspecialCharacters . . . . .	968
60.1.7 defvar \$RTspecialCharacters . . . . .	968
60.1.8 defvar \$specialCharacters . . . . .	969
60.1.9 defvar \$specialCharacterAlist . . . . .	969
60.1.10 defun Look up a special character code for a symbol . . . . .	970
<b>61 Stream and File Handling</b>	<b>971</b>
61.0.11 defun make-instream . . . . .	971
61.0.12 defun make-outstream . . . . .	971
61.0.13 defun make-appendstream . . . . .	972
61.0.14 defun defiostream . . . . .	972
61.0.15 defun shut . . . . .	972
61.0.16 defun eofp . . . . .	973
61.0.17 defun makeStream . . . . .	973
61.0.18 defun Construct a new input file name . . . . .	973
61.0.19 defun getDirectoryList . . . . .	974
61.0.20 defun probeName . . . . .	974
61.0.21 defun makeFullNamestring . . . . .	975
61.0.22 defun Replace a file by erase and rename . . . . .	975
<b>62 The Spad Server Mechanism</b>	<b>977</b>
62.0.23 defun openserver . . . . .	977
<b>63 Axiom Build-time Functions</b>	<b>979</b>
63.0.24 defun spad-save . . . . .	979
<b>64 Exposure Groups</b>	<b>981</b>

<b>65 Databases</b>	<b>983</b>
65.1 Database structure . . . . .	983
65.1.1 kaf File Format . . . . .	983
65.1.2 Database Files . . . . .	984
65.1.3 defstruct \$database . . . . .	986
65.1.4 defvar \$*defaultdomain-list* . . . . .	987
65.1.5 defvar \$*operation-hash* . . . . .	987
65.1.6 defvar \$*hasCategory-hash* . . . . .	987
65.1.7 defvar \$*miss* . . . . .	988
65.1.8 Database streams . . . . .	988
65.1.9 defvar \$*compressvector* . . . . .	988
65.1.10 defvar \$*compressVectorLength* . . . . .	988
65.1.11 defvar \$*compress-stream* . . . . .	989
65.1.12 defvar \$*compress-stream-stamp* . . . . .	989
65.1.13 defvar \$*interp-stream* . . . . .	989
65.1.14 defvar \$*interp-stream-stamp* . . . . .	989
65.1.15 defvar \$*operation-stream* . . . . .	989
65.1.16 defvar \$*operation-stream-stamp* . . . . .	990
65.1.17 defvar \$*browse-stream* . . . . .	990
65.1.18 defvar \$*browse-stream-stamp* . . . . .	990
65.1.19 defvar \$*category-stream* . . . . .	990
65.1.20 defvar \$*category-stream-stamp* . . . . .	991
65.1.21 defvar \$*allconstructors* . . . . .	991
65.1.22 defvar \$*allOperations* . . . . .	991
65.1.23 defun Reset all hash tables before saving system . . . . .	991
65.1.24 defun Preload algebra into saved system . . . . .	992
65.1.25 defun Open the interp database . . . . .	994
65.1.26 defun Open the browse database . . . . .	996
65.1.27 defun Open the category database . . . . .	997
65.1.28 defun Open the operations database . . . . .	998
65.1.29 defun Add operations from newly compiled code . . . . .	998
65.1.30 defun Show all database attributes of a constructor . . . . .	999
65.1.31 defun Set a value for a constructor key in the database . . . . .	1000
65.1.32 defun Delete a value for a constructor key in the database . . . . .	1001
65.1.33 defun Get constructor information for a database key . . . . .	1001
65.1.34 defun The <code>)library</code> top level command . . . . .	1005
65.1.35 defun Read a local filename and update the hash tables . . . . .	1005
65.1.36 defun Update the database from an <code>nrlib</code> index.kaf file . . . . .	1007
65.1.37 defun updateDatabase . . . . .	1009
65.1.38 defun Make new databases . . . . .	1009
65.1.39 defun saveDependentsHashTable . . . . .	1013
65.1.40 defun saveUsersHashTable . . . . .	1014
65.1.41 defun Construct the proper database full pathname . . . . .	1014
65.1.42 compress.daase . . . . .	1015
65.1.43 defun Set up compression vectors for the databases . . . . .	1015
65.1.44 defvar \$*attributes* . . . . .	1016

65.1.45 defun Write out the compress database . . . . .	1016
65.1.46 defun Compress an expression using the compress vector . . . . .	1017
65.1.47 defun Uncompress an expression using the compress vector . . . . .	1018
65.1.48 Building the interp.daase from hash tables . . . . .	1018
65.1.49 defun Write the interp database . . . . .	1022
65.1.50 Building the browse.daase from hash tables . . . . .	1024
65.1.51 defun Write the browse database . . . . .	1024
65.1.52 Building the category.daase from hash tables . . . . .	1025
65.1.53 defun Write the category database . . . . .	1025
65.1.54 Building the operation.daase from hash tables . . . . .	1026
65.1.55 defun Write the operations database . . . . .	1026
65.1.56 Database support operations . . . . .	1027
65.1.57 defun Data preloaded into the image at build time . . . . .	1027
65.1.58 defun Return all constructors . . . . .	1027
65.1.59 defun Return all operations . . . . .	1027
<b>66 System Statistics</b>	<b>1029</b>
66.1 Lisp Library Handling . . . . .	1029
66.1.1 defun loadLib . . . . .	1029
66.1.2 defun isSystemDirectory . . . . .	1030
66.1.3 defun loadLibNoUpdate . . . . .	1031
66.1.4 defun loadFuncor . . . . .	1032
<b>67 Special Lisp Functions</b>	<b>1033</b>
67.1 Axiom control structure macros . . . . .	1033
67.1.1 defun put . . . . .	1033
67.1.2 defmacro while . . . . .	1033
67.1.3 defmacro whileWithResult . . . . .	1034
67.2 Filename Handling . . . . .	1034
67.2.1 defun namestring . . . . .	1034
67.2.2 defun pathnameName . . . . .	1034
67.2.3 defun pathnameType . . . . .	1034
67.2.4 defun pathnameTypeId . . . . .	1035
67.2.5 defun mergePathnames . . . . .	1035
67.2.6 defun pathnameDirectory . . . . .	1035
67.2.7 defun Axiom pathnames . . . . .	1036
67.2.8 defun makePathname . . . . .	1036
67.2.9 defun Delete a file . . . . .	1036
67.2.10 defun wrap . . . . .	1037
67.2.11 defun lotsof . . . . .	1037
67.2.12 defmacro startsId? . . . . .	1038
67.2.13 defun hput . . . . .	1038
67.2.14 defmacro hget . . . . .	1038
67.2.15 defun hkeys . . . . .	1038
67.2.16 defun digitp . . . . .	1039
67.2.17 defun pname . . . . .	1039

67.2.18 defun size . . . . .	1039
67.2.19 defun strpos . . . . .	1039
67.2.20 defun strposl . . . . .	1040
67.2.21 defun qenum . . . . .	1040
67.2.22 defmacro identp . . . . .	1040
67.2.23 defun concat . . . . .	1041
67.2.24 defun functionp . . . . .	1041
67.2.25 defun brightprint . . . . .	1041
67.2.26 defun brightprint-0 . . . . .	1042
67.2.27 defun member . . . . .	1042
67.2.28 defun messageprint . . . . .	1042
67.2.29 defun messageprint-1 . . . . .	1043
67.2.30 defun messageprint-2 . . . . .	1043
67.2.31 defun sayBrightly1 . . . . .	1043
67.2.32 defmacro assq . . . . .	1044
<b>68 Record, Union, Mapping, and Enumeration</b>	<b>1045</b>
<b>69 Common Lisp Algebra Support</b>	<b>1047</b>
69.1 Void . . . . .	1047
69.1.1 defun voidValue . . . . .	1047
69.2 U32Vector . . . . .	1048
69.2.1 defun getrefv32 . . . . .	1048
69.2.2 defmacro qv32len . . . . .	1048
69.2.3 defmacro elt32 . . . . .	1048
69.2.4 defmacro setelt32 . . . . .	1048
69.3 DirectProduct . . . . .	1049
69.3.1 defun vec2list . . . . .	1049
69.4 AlgebraicFunction . . . . .	1049
69.4.1 defun retract . . . . .	1049
69.5 Any . . . . .	1051
69.5.1 defun spad2BootCoerce . . . . .	1051
69.6 ParametricLinearEquations . . . . .	1051
69.6.1 defun algCoerceInteractive . . . . .	1051
69.7 NumberFormats . . . . .	1052
69.7.1 defun ncParseFromString . . . . .	1052
69.8 SingleInteger . . . . .	1052
69.8.1 defun qsquotient . . . . .	1052
69.8.2 defun qsremainder . . . . .	1052
69.8.3 defmacro qsdifference . . . . .	1052
69.8.4 defmacro qslessp . . . . .	1053
69.8.5 defmacro qsadd1 . . . . .	1053
69.8.6 defmacro qssub1 . . . . .	1053
69.8.7 defmacro qsminus . . . . .	1053
69.8.8 defmacro qsplus . . . . .	1054
69.8.9 defmacro qstimes . . . . .	1054

69.8.10 defmacro qsabsval . . . . .	1054
69.8.11 defmacro qsoddp . . . . .	1054
69.8.12 defmacro qszerop . . . . .	1055
69.8.13 defmacro qsmax . . . . .	1055
69.8.14 defmacro qsmin . . . . .	1055
69.9 Boolean . . . . .	1055
69.9.1 defun The Boolean = function support . . . . .	1055
69.10 IndexedBits . . . . .	1056
69.10.1 defmacro truth-to-bit . . . . .	1056
69.10.2 defun IndexedBits new function support . . . . .	1056
69.10.3 defmacro bit-to-truth . . . . .	1056
69.10.4 defmacro bvec-elt . . . . .	1056
69.10.5 defmacro bvec-setelt . . . . .	1057
69.10.6 defmacro bvec-size . . . . .	1057
69.10.7 defun IndexedBits concat function support . . . . .	1057
69.10.8 defun IndexedBits copy function support . . . . .	1057
69.10.9 defun IndexedBits = function support . . . . .	1057
69.10.10 defun IndexedBits < function support . . . . .	1058
69.10.11 defun IndexedBits And function support . . . . .	1058
69.10.12 defun IndexedBits Or function support . . . . .	1058
69.10.13 defun IndexedBits xor function support . . . . .	1058
69.10.14 defun IndexedBits nand function support . . . . .	1059
69.10.15 defun IndexedBits nor function support . . . . .	1059
69.10.16 defun IndexedBits not function support . . . . .	1059
69.11 KeyedAccessFile . . . . .	1059
69.11.1 defun KeyedAccessFile defstream function support . . . . .	1059
69.11.2 defun KeyedAccessFile defstream function support . . . . .	1060
69.12 Table . . . . .	1060
69.12.1 defun Table InnerTable support . . . . .	1060
69.12.2 defun compiledLookup . . . . .	1061
69.12.3 defun basicLookup . . . . .	1061
69.12.4 defun lookupInDomainVector . . . . .	1063
69.12.5 defun basicLookupCheckDefaults . . . . .	1063
69.12.6 defun oldCompLookup . . . . .	1064
69.12.7 defun NRTEvalDomain . . . . .	1064
69.13 Plot3d . . . . .	1065
69.13.1 defvar \$numericFailure . . . . .	1065
69.13.2 defvar \$oldBreakMode . . . . .	1065
69.13.3 defmacro trapNumericErrors . . . . .	1065
69.14 DoubleFloatVector . . . . .	1066
69.14.1 defmacro dlen . . . . .	1066
69.14.2 defmacro make-double-vector . . . . .	1066
69.14.3 defmacro make-double-vector1 . . . . .	1066
69.14.4 defmacro delt . . . . .	1067
69.14.5 defmacro dsetelt . . . . .	1067
69.15 ComplexDoubleFloatVector . . . . .	1067



69.15.1 defmacro make-cdouble-vector . . . . .	1067
69.15.2 defmacro cdelt . . . . .	1067
69.15.3 defmacro cdsetelt . . . . .	1068
69.15.4 defmacro cdlen . . . . .	1068
69.16 DoubleFloatMatrix . . . . .	1069
69.16.1 defmacro make-double-matrix . . . . .	1069
69.16.2 defmacro make-double-matrix1 . . . . .	1069
69.16.3 defmacro daref2 . . . . .	1069
69.16.4 defmacro dsetaref2 . . . . .	1069
69.16.5 defmacro danrows . . . . .	1070
69.16.6 defmacro dancols . . . . .	1070
69.17 ComplexDoubleFloatMatrix . . . . .	1070
69.17.1 defmacro make-cdouble-matrix . . . . .	1070
69.17.2 defmacro cdaref2 . . . . .	1070
69.17.3 defmacro cdsetaref2 . . . . .	1071
69.17.4 defmacro cdanrows . . . . .	1071
69.17.5 defmacro cdancols . . . . .	1072
69.18 Integer . . . . .	1072
69.18.1 defun Integer divide function support . . . . .	1072
69.18.2 defun Integer quo function support . . . . .	1072
69.18.3 defun Integer quo function support . . . . .	1073
69.18.4 defun Integer random function support . . . . .	1073
69.19 IndexCard . . . . .	1073
69.19.1 defun IndexCard origin function support . . . . .	1073
69.19.2 defun IndexCard origin function support . . . . .	1074
69.19.3 defun IndexCard elt function support . . . . .	1074
69.20 OperationsQuery . . . . .	1074
69.20.1 defun OperationQuery getDatabase function support . . . . .	1074
69.21 Database . . . . .	1075
69.21.1 defun Database elt function support . . . . .	1075
69.22 FileName . . . . .	1075
69.22.1 defun FileName filename function implementation . . . . .	1075
69.22.2 defun FileName filename support function . . . . .	1076
69.22.3 defun FileName directory function implementation . . . . .	1076
69.22.4 defun FileName directory function support . . . . .	1076
69.22.5 defun FileName name function implementation . . . . .	1077
69.22.6 defun FileName extension function implementation . . . . .	1077
69.22.7 defun FileName exists? function implementation . . . . .	1077
69.22.8 defun FileName readable? function implementation . . . . .	1077
69.22.9 defun FileName writeable? function implementation . . . . .	1078
69.22.10 defun FileName writeable? function support . . . . .	1078
69.22.11 defun FileName new function implementation . . . . .	1078
69.23 DoubleFloat . . . . .	1079
69.23.1 defmacro DFLessThan . . . . .	1079
69.23.2 defmacro DFUnaryMinus . . . . .	1079
69.23.3 defmacro DFMinusp . . . . .	1079

69.23.4	defmacro DFZerop . . . . .	1079
69.23.5	defmacro DFAdd . . . . .	1080
69.23.6	defmacro DFSubtract . . . . .	1080
69.23.7	defmacro DFMultiply . . . . .	1080
69.23.8	defmacro DFIntegerMultiply . . . . .	1080
69.23.9	defmacro DFMax . . . . .	1081
69.23.10	defmacro DFMin . . . . .	1081
69.23.11	defmacro DFEql . . . . .	1081
69.23.12	defmacro DFDivide . . . . .	1081
69.23.13	defmacro DFIntegerDivide . . . . .	1082
69.23.14	defmacro DFSqrt . . . . .	1082
69.23.15	defmacro DFLogE . . . . .	1082
69.23.16	defmacro DFLog . . . . .	1082
69.23.17	defmacro DFIntegerExpt . . . . .	1083
69.23.18	defmacro DFExpt . . . . .	1083
69.23.19	defmacro DFExp . . . . .	1083
69.23.20	defmacro DFSin . . . . .	1083
69.23.21	defmacro DFCos . . . . .	1084
69.23.22	defmacro DFTan . . . . .	1084
69.23.23	defmacro DFAasin . . . . .	1084
69.23.24	defmacro DFAcos . . . . .	1084
69.23.25	defmacro DFAtan . . . . .	1085
69.23.26	defmacro DFAtan2 . . . . .	1085
69.23.27	defmacro DFSinh . . . . .	1085
69.23.28	defmacro DFCosh . . . . .	1086
69.23.29	defmacro DFTanh . . . . .	1086
69.23.30	defmacro DFAsinh . . . . .	1086
69.23.31	defmacro DFAcosh . . . . .	1087
69.23.32	defmacro DFAtanh . . . . .	1087
69.23.33	defun Machine specific float numerator . . . . .	1087
69.23.34	defun Machine specific float denominator . . . . .	1088
69.23.35	defun Machine specific float sign . . . . .	1088
69.23.36	defun Machine specific float bit length . . . . .	1088
69.23.37	defun Decode floating-point values . . . . .	1088
69.23.38	defun The cotangent routine . . . . .	1089
69.23.39	defun The inverse cotangent function . . . . .	1089
69.23.40	defun The secant function . . . . .	1089
69.23.41	defun The inverse secant function . . . . .	1090
69.23.42	defun The cosecant function . . . . .	1090
69.23.43	defun The inverse cosecant function . . . . .	1090
69.23.44	defun The hyperbolic cosecant function . . . . .	1091
69.23.45	defun The hyperbolic cotangent function . . . . .	1091
69.23.46	defun The hyperbolic secant function . . . . .	1091
69.23.47	defun The inverse hyperbolic cosecant function . . . . .	1091
69.23.48	defun The inverse hyperbolic cotangent function . . . . .	1092
69.23.49	defun The inverse hyperbolic secant function . . . . .	1092

<b>70 OpenMath</b>	<b>1093</b>
70.1 A Technical Overview[?]	1093
70.1.1 The OpenMath Architecture	1093
70.1.2 OpenMath Encodings	1095
70.1.3 Content Dictionaries	1096
70.1.4 OpenMath in Action	1098
70.2 Technical Details[?]	1099
70.3 The Structure of the API	1099
70.4 OpenMath Expressions	1100
70.4.1 Expressions	1100
70.4.2 Symbols	1100
70.4.3 Encoding and Decoding OpenMath Expressions	1100
70.5 Big Integers	1101
70.6 Functions Dealing with OpenMath Devices	1101
70.7 Functions to Write OpenMath Expressions to Devices	1102
70.7.1 Beginning and Ending Objects	1102
70.7.2 Writing Basic Objects	1103
70.7.3 Writing Structured Objects	1103
70.8 Functions to Extract OpenMath Expressions from Devices	1104
70.8.1 Testing the type of the current token	1104
70.8.2 Extracting the current token	1105
70.9 Comments in the SGML/XML Encodings	1108
70.10 I/O Functions for Devices	1109
70.11 Communications	1109
70.11.1 Functions to Initiate an OMconn	1110
70.12 Parameters	1111
70.13 Miscellaneous Functions and Variables	1111
70.14 The OM.h header file	1112
70.15 Axiom OpenMath stub functions	1121
70.15.1 Axiom specific functions	1121
70.15.2 defun om-Read	1121
70.15.3 defun om-listCDs	1122
70.15.4 defun om-listSymbols	1122
70.15.5 defun om-supportsCD	1122
70.15.6 defun om-supportsSymbol	1122
70.15.7 Lisp conversion functions	1123
70.15.8 defun om-setDevEncoding	1123
70.15.9 Device manipulation functions	1123
70.15.10 defun om-openFileDev	1123
70.15.11 defun om-openStringDev	1124
70.15.12 defun om-closeDev	1124
70.15.13 Connection manipulation functions	1124
70.15.14 defun om-makeConn	1124
70.15.15 defun om-closeConn	1124
70.15.16 defun om-getConnInDev	1125
70.15.17 defun om-getConnOutDev	1125

70.15.18	Client/Server functions . . . . .	1125
70.15.19	defun om-bindTCP . . . . .	1125
70.15.20	defun om-connectTCP . . . . .	1126
70.15.21	Device input/output functions . . . . .	1126
70.15.22	defun om-getApp . . . . .	1127
70.15.23	defun om-getAtp . . . . .	1128
70.15.24	defun om-getAttr . . . . .	1128
70.15.25	defun om-getBind . . . . .	1128
70.15.26	defun om-getBVar . . . . .	1128
70.15.27	defun om-getByteArray . . . . .	1129
70.15.28	defun om-getEndApp . . . . .	1129
70.15.29	defun om-getEndAtp . . . . .	1129
70.15.30	defun om-getEndAttr . . . . .	1129
70.15.31	defun om-getEndBind . . . . .	1130
70.15.32	defun om-getEndBVar . . . . .	1130
70.15.33	defun om-getEndError . . . . .	1130
70.15.34	defun om-getEndObject . . . . .	1130
70.15.35	defun om-getError . . . . .	1131
70.15.36	defun om-getFloat . . . . .	1131
70.15.37	defun om-getInt . . . . .	1131
70.15.38	defun om-getObject . . . . .	1131
70.15.39	defun om-getString . . . . .	1132
70.15.40	defun om-getSymbol . . . . .	1132
70.15.41	defun om-getType . . . . .	1132
70.15.42	defun om-getVar . . . . .	1132
70.15.43	defun om-putApp . . . . .	1133
70.15.44	defun om-putAtp . . . . .	1133
70.15.45	defun om-putAttr . . . . .	1133
70.15.46	defun om-putBind . . . . .	1133
70.15.47	defun om-putBVar . . . . .	1134
70.15.48	defun om-putByteArray . . . . .	1134
70.15.49	defun om-putEndApp . . . . .	1134
70.15.50	defun om-putEndAtp . . . . .	1134
70.15.51	defun om-putEndAttr . . . . .	1135
70.15.52	defun om-putEndBind . . . . .	1135
70.15.53	defun om-putEndBVar . . . . .	1135
70.15.54	defun om-putEndError . . . . .	1135
70.15.55	defun om-putEndObject . . . . .	1136
70.15.56	defun om-putError . . . . .	1136
70.15.57	defun om-putFloat . . . . .	1136
70.15.58	defun om-putInt . . . . .	1136
70.15.59	defun om-putObject . . . . .	1137
70.15.60	defun om-putString . . . . .	1137
70.15.61	defun om-putSymbol . . . . .	1137
70.15.62	defun om-putVar . . . . .	1137
70.15.63	defun om-stringToStringPtr . . . . .	1138

70.15.64	defun om-stringPtrToString . . . . .	1138
<b>71</b>	<b>NRLIB code.lisp support code</b>	<b>1139</b>
71.0.65	defun makeByteWordVec2 . . . . .	1139
71.0.66	defmacro spadConstant . . . . .	1139
<b>72</b>	<b>Monitoring execution</b>	<b>1141</b>
72.0.67	defvar \$*monitor-domains* . . . . .	1147
72.0.68	defvar \$*monitor-nrlibs* . . . . .	1147
72.0.69	defvar \$*monitor-table* . . . . .	1148
72.0.70	defstruct \$monitor-data . . . . .	1148
72.0.71	defstruct \$libstream . . . . .	1148
72.0.72	defun Initialize the monitor statistics hashtable . . . . .	1148
72.0.73	defun End the monitoring process, we cannot restart . . . . .	1149
72.0.74	defun Return a list of the monitor-data structures . . . . .	1149
72.0.75	defun Add a function to be monitored . . . . .	1150
72.0.76	defun Remove a function being monitored . . . . .	1150
72.0.77	defun Enable all (or optionally one) function for monitoring . . . . .	1150
72.0.78	defun Disable all (optionally one) function for monitoring . . . . .	1151
72.0.79	defun Reset the table count for the table (or a function) . . . . .	1151
72.0.80	defun Incr the count of fn by 1 . . . . .	1152
72.0.81	defun Decr the count of fn by 1 . . . . .	1152
72.0.82	defun Return the monitor information for a function . . . . .	1153
72.0.83	defun Hang a monitor call on all of the defuns in a file . . . . .	1153
72.0.84	defun Return a list of the functions with zero count fields . . . . .	1153
72.0.85	defun Return a list of functions with non-zero counts . . . . .	1154
72.0.86	defun Write out a list of symbols or structures to a file . . . . .	1154
72.0.87	defun Save the *monitor-table* in loadable form . . . . .	1155
72.0.88	defun restore a checkpointed file . . . . .	1155
72.0.89	defun Printing help documentation . . . . .	1156
72.0.90	Monitoring algebra files . . . . .	1158
72.0.91	defun Monitoring algebra code.lsp files . . . . .	1158
72.0.92	defun Monitor autoloaded files . . . . .	1158
72.0.93	defun Monitor an nrlib . . . . .	1159
72.0.94	defun Given a monitor-data item, extract the nrlib name . . . . .	1159
72.0.95	defun Is this an exposed algebra function? . . . . .	1160
72.0.96	defun Monitor exposed domains . . . . .	1160
72.0.97	defun Generate a report of the monitored domains . . . . .	1161
72.0.98	defun Parse an )abbrev expression for the domain name . . . . .	1162
72.0.99	defun Given a spad file, report all nrlibs it creates . . . . .	1162
72.0.100	defun Print percent of functions tested . . . . .	1163
72.0.101	defun Find all monitored symbols containing the string . . . . .	1163
<b>73</b>	<b>The Interpreter</b>	<b>1165</b>

<b>74 The Global Variables</b>	<b>1199</b>
74.1 Star Global Variables . . . . .	1199
74.1.1 *eof* . . . . .	1199
74.1.2 *features* . . . . .	1199
74.1.3 *package* . . . . .	1199
74.1.4 *standard-input* . . . . .	1200
74.1.5 *standard-output* . . . . .	1200
74.1.6 *top-level-hook* . . . . .	1200
74.2 Dollar Global Variables . . . . .	1202
74.2.1 \$boot . . . . .	1203
74.2.2 coerceFailure . . . . .	1203
74.2.3 \$currentLine . . . . .	1203
74.2.4 \$displayStartMsgs . . . . .	1203
74.2.5 \$e . . . . .	1203
74.2.6 \$erMsgToss . . . . .	1203
74.2.7 \$fn . . . . .	1203
74.2.8 \$frameRecord . . . . .	1203
74.2.9 \$HiFiAccess . . . . .	1204
74.2.10 \$HistList . . . . .	1204
74.2.11 \$HistListAct . . . . .	1204
74.2.12 \$HistListLen . . . . .	1204
74.2.13 \$HistRecord . . . . .	1204
74.2.14 \$historyFileType . . . . .	1205
74.2.15 \$internalHistoryTable . . . . .	1205
74.2.16 \$interpreterFrameName . . . . .	1205
74.2.17 \$interpreterFrameRing . . . . .	1205
74.2.18 \$InteractiveFrame . . . . .	1205
74.2.19 \$intRestart . . . . .	1205
74.2.20 \$intTopLevel . . . . .	1205
74.2.21 \$IOindex . . . . .	1206
74.2.22 \$lastPos . . . . .	1206
74.2.23 \$libQuiet . . . . .	1206
74.2.24 \$msgDatabaseName . . . . .	1206
74.2.25 \$ncMsgList . . . . .	1206
74.2.26 \$newcompErrorCount . . . . .	1206
74.2.27 \$newspad . . . . .	1206
74.2.28 \$nopus . . . . .	1206
74.2.29 \$oldHistoryFileName . . . . .	1207
74.2.30 \$okToExecuteMachineCode . . . . .	1207
74.2.31 \$options . . . . .	1207
74.2.32 \$previousBindings . . . . .	1207
74.2.33 \$PrintCompilerMessageIfTrue . . . . .	1207
74.2.34 \$reportUndo . . . . .	1207
74.2.35 \$spad . . . . .	1207
74.2.36 \$SpadServer . . . . .	1208
74.2.37 \$SpadServerName . . . . .	1208

<i>CONTENTS</i>	71
74.2.38 \$systemCommandFunction . . . . .	1208
74.2.39 top_level . . . . .	1208
74.2.40 \$quitTag . . . . .	1208
74.2.41 \$useInternalHistoryTable . . . . .	1208
74.2.42 \$undoFlag . . . . .	1208
<b>75 Index</b>	<b>1211</b>

## Volume 6: Axiom Command

<b>1</b>	<b>Overview</b>	<b>1</b>
<b>2</b>	<b>The axiom Command</b>	<b>3</b>
2.0.1	[-ht   -noht]	3
2.0.2	[-gr   -nogr]	4
2.0.3	[-clef   -noclef]	4
2.0.4	[-nonag   -nag]	5
2.0.5	[-noiw   -iw]	5
2.0.6	[-ihere   -noihere]	6
2.0.7	[-nox]	6
2.0.8	[-go   -nogo]	7
2.0.9	[-ws wsname]	7
2.0.10	[-list]	7
2.0.11	[-grprog fname]	7
2.0.12	[-nagprog fname]	8
2.0.13	[-htprog fname]	8
2.0.14	[-clefprog fname]	8
2.0.15	[-sessionprog fname]	8
2.0.16	[-clientprog fname]	8
2.0.17	[-h]	8
<b>3</b>	<b>The sman program</b>	<b>17</b>
3.1	sman.h	17
3.2	sman	18
3.2.1	includes	18
3.2.2	variables	18
3.2.3	process_arguments	20
3.2.4	should_L_clef	23
3.2.5	in_X	23
3.2.6	set_up_defaults	23
3.2.7	process_options	24
3.2.8	death_handler	24
3.2.9	nagman_handler	24
3.2.10	sman_catch_signals	25
3.2.11	fix_env	26
3.2.12	init_term_io	26
3.2.13	strPrefix	27
3.2.14	check_spad_proc	27
3.2.15	clean_up_old_sockets	28
3.2.16	fork_you	28
3.2.17	exec_command_env	29
3.2.18	spawn_of_hell	29
3.2.19	start_the_spadclient	30



3.2.20	start_the_local_spadclient . . . . .	30
3.2.21	start_the_nagman . . . . .	31
3.2.22	start_the_session_manager . . . . .	31
3.2.23	start_the_hypertext . . . . .	32
3.2.24	start_the_graphics . . . . .	32
3.2.25	fork_Axiom . . . . .	32
3.2.26	start_the_Axiom . . . . .	34
3.2.27	clean_up_sockets . . . . .	35
3.2.28	read_from_spad_io . . . . .	35
3.2.29	read_from_manager . . . . .	36
3.2.30	manage_spad_io . . . . .	37
3.2.31	init_spad_process_list . . . . .	38
3.2.32	print_spad_process_list . . . . .	38
3.2.33	find_child . . . . .	38
3.2.34	kill_all_children . . . . .	39
3.2.35	clean_up_terminal . . . . .	39
3.2.36	monitor_children . . . . .	39
3.2.37	main sman . . . . .	41
3.2.38	sman . . . . .	42
<b>4</b>	<b>Support Routines</b>	<b>45</b>
4.1	Command Completion . . . . .	45
<b>5</b>	<b>The viewman program</b>	<b>47</b>
<b>6</b>	<b>The nagman program</b>	<b>49</b>
6.1	nag.x . . . . .	49
6.2	nagman . . . . .	50
6.2.1	includes . . . . .	50
6.2.2	variables . . . . .	51
6.2.3	term . . . . .	52
6.2.4	size_of_file . . . . .	53
6.2.5	rpcloop . . . . .	53
6.2.6	catchSignals . . . . .	59
6.2.7	main nagman . . . . .	60
6.2.8	nagman . . . . .	61
<b>7</b>	<b>The hypertext program</b>	<b>63</b>
<b>8</b>	<b>The clef program</b>	<b>65</b>
<b>9</b>	<b>The session program</b>	<b>67</b>
9.1	session . . . . .	67
9.1.1	includes . . . . .	67
9.1.2	variables . . . . .	68
9.1.3	usr1_handler . . . . .	68

9.1.4	usr2_handler . . . . .	68
9.1.5	term_handler . . . . .	69
9.1.6	pr . . . . .	69
9.1.7	close_client . . . . .	70
9.1.8	read_SpadServer_command . . . . .	71
9.1.9	test_sock_for_process . . . . .	72
9.1.10	read_menu_client_command . . . . .	72
9.1.11	read_from_spad_io . . . . .	73
9.1.12	kill_spad . . . . .	74
9.1.13	accept_session_connection . . . . .	74
9.1.14	read_from_session . . . . .	76
9.1.15	manage_sessions . . . . .	77
9.1.16	main sessionmanager . . . . .	78
9.1.17	session . . . . .	80
<b>10</b>	<b>The spadclient program</b>	<b>81</b>
10.1	spadclient . . . . .	81
<b>11</b>	<b>The Command Completion List</b>	<b>83</b>
<b>12</b>	<b>Research Topics</b>	<b>167</b>
12.1	Proofs . . . . .	167
12.2	Indefinites . . . . .	167
12.3	Provisos . . . . .	168
<b>13</b>	<b>Makefile</b>	<b>169</b>
13.1	Environment variables . . . . .	169
13.2	The axiom command . . . . .	170
13.3	session . . . . .	170
13.4	nagman . . . . .	170
13.5	spadclient . . . . .	171
13.6	sman . . . . .	171

## Volume 7: Axiom Hyperdoc

<b>1</b>	<b>Overview</b>	<b>1</b>
1.1	The Original Plan . . . . .	2
1.2	External Variables . . . . .	3
1.3	hypertex . . . . .	4
1.4	htsearch . . . . .	4
1.5	spadbuf . . . . .	4
1.6	hthits . . . . .	4
1.7	ex2ht . . . . .	4
1.8	htadd . . . . .	4
<b>2</b>	<b>The hypertex language</b>	<b>5</b>
<b>3</b>	<b>Hypertex Call Graph</b>	<b>31</b>
<b>4</b>	<b>Shared Code</b>	<b>87</b>
4.0.1	BeStruct . . . . .	87
4.1	Shared Code for file handling . . . . .	87
4.1.1	strpostfix . . . . .	87
4.1.2	extendHT . . . . .	88
4.1.3	buildHtFilename . . . . .	88
4.1.4	pathname . . . . .	90
4.1.5	htFileOpen . . . . .	91
4.1.6	dbFileOpen . . . . .	91
4.1.7	tempFileOpen . . . . .	93
4.2	Shared Code for Hash Table Handling . . . . .	93
4.2.1	halloc . . . . .	93
4.2.2	hashInit . . . . .	94
4.2.3	freeHash . . . . .	94
4.2.4	hashInsert . . . . .	95
4.2.5	hashFind . . . . .	95
4.2.6	hashReplace . . . . .	95
4.2.7	hashDelete . . . . .	96
4.2.8	hashMap . . . . .	96
4.2.9	hashCopyEntry . . . . .	97
4.2.10	hashCopyTable . . . . .	97
4.2.11	stringHash . . . . .	97
4.2.12	stringEqual . . . . .	98
4.2.13	allocString . . . . .	98
4.3	Shared Code for Error Handling . . . . .	98
4.3.1	jump . . . . .	98
4.3.2	dumpToken . . . . .	99
4.3.3	printPageAndFilename . . . . .	99
4.3.4	printNextTenTokens . . . . .	100

4.3.5	printToken . . . . .	100
4.3.6	tokenName . . . . .	101
4.3.7	htperror . . . . .	102
4.4	Shared Code for Lexical Analyzer . . . . .	103
4.4.1	parserInit . . . . .	104
4.4.2	initScanner . . . . .	104
4.4.3	saveScannerState . . . . .	105
4.4.4	restoreScannerState . . . . .	105
4.4.5	ungetChar . . . . .	106
4.4.6	getChar . . . . .	106
4.4.7	getChar1 . . . . .	107
4.4.8	ungetToken . . . . .	109
4.4.9	getToken . . . . .	109
4.4.10	pushBeStack . . . . .	112
4.4.11	checkAndPopBeStack . . . . .	113
4.4.12	clearBeStack . . . . .	113
4.4.13	beType . . . . .	114
4.4.14	beginType . . . . .	115
4.4.15	endType . . . . .	116
4.4.16	keywordType . . . . .	117
4.4.17	getExpectedToken . . . . .	118
4.4.18	spadErrorHandler . . . . .	118
4.4.19	resetConnection . . . . .	119
4.4.20	spadBusy . . . . .	119
4.4.21	connectSpad . . . . .	120
4.5	htadd shared code . . . . .	120
4.6	hypertext shared code . . . . .	124
<b>5</b>	<b>Shared include files</b>	<b>129</b>
5.1	debug.c . . . . .	129
5.2	hyper.h . . . . .	129
<b>6</b>	<b>The spadbuf function</b>	<b>141</b>
6.1	spadbuf Call Graph . . . . .	141
6.2	Constants and Headers . . . . .	142
6.2.1	System includes . . . . .	142
6.2.2	Local includes . . . . .	142
6.3	externs . . . . .	143
6.4	local variables . . . . .	143
6.5	Code . . . . .	144
6.5.1	spadbufInterHandler . . . . .	144
6.5.2	spadbufFunctionChars . . . . .	144
6.5.3	interpIO . . . . .	145
6.5.4	. . . . .	146
6.5.5	main . . . . .	147

<b>7</b>	<b>The ex2ht function</b>	<b>149</b>
7.1	ex2ht Call Graph . . . . .	149
7.2	ex2ht Source Code . . . . .	150
7.3	Constants and Headers . . . . .	150
7.3.1	System includes . . . . .	150
7.3.2	Local includes . . . . .	151
7.4	defines . . . . .	151
7.5	local variables . . . . .	151
7.6	Code . . . . .	151
7.6.1	allocString . . . . .	151
7.6.2	strPrefix . . . . .	152
7.6.3	getExTitle . . . . .	152
7.6.4	exToHt . . . . .	153
7.6.5	emitHeader . . . . .	154
7.6.6	emitFooter . . . . .	154
7.6.7	emitMenuEntry . . . . .	154
7.6.8	emitSpadCommand . . . . .	155
7.6.9	openCoverPage . . . . .	155
7.6.10	closeCoverPage . . . . .	156
7.6.11	closeCoverFile . . . . .	156
7.6.12	emitCoverLink . . . . .	156
7.6.13	addFile . . . . .	157
7.6.14	main . . . . .	157
<b>8</b>	<b>The htadd command</b>	<b>159</b>
8.1	htadd Call Graph . . . . .	159
8.2	Constants and Headers . . . . .	164
8.2.1	System includes . . . . .	164
8.2.2	structs . . . . .	164
8.2.3	Local includes . . . . .	164
8.2.4	extern references . . . . .	165
8.2.5	defines . . . . .	165
8.2.6	forward declarations . . . . .	166
8.2.7	local variables . . . . .	166
8.3	The Shared Code . . . . .	167
8.4	Code . . . . .	167
8.4.1	parseArgs . . . . .	167
8.4.2	writable . . . . .	168
8.4.3	buildDBFilename . . . . .	168
8.4.4	addfile . . . . .	170
8.4.5	updateDB . . . . .	171
8.4.6	addNewPages . . . . .	172
8.4.7	copyFile . . . . .	173
8.4.8	getFilename . . . . .	174
8.4.9	deleteFile . . . . .	175
8.4.10	deleteDB . . . . .	175

8.4.11	main . . . . .	176
<b>9</b>	<b>The hthits function</b>	<b>179</b>
9.1	hthits Call Graph . . . . .	179
9.2	Constants and Headers . . . . .	181
9.2.1	System includes . . . . .	181
9.2.2	defines . . . . .	181
9.2.3	structs . . . . .	181
9.2.4	Local includes . . . . .	182
9.2.5	local variables . . . . .	182
9.2.6	cmdline . . . . .	182
9.2.7	handleHtdb . . . . .	182
9.2.8	handleFile . . . . .	183
9.2.9	handleFilePages . . . . .	185
9.2.10	handlePage . . . . .	185
9.2.11	searchPage . . . . .	186
9.2.12	squirt . . . . .	187
9.2.13	splitpage . . . . .	187
9.2.14	untexbuf . . . . .	188
9.2.15	badDB . . . . .	189
9.2.16	regerr . . . . .	189
9.2.17	main . . . . .	189
<b>10</b>	<b>The hypertext command</b>	<b>191</b>
10.1	Constants and Headers . . . . .	191
10.1.1	System includes . . . . .	191
10.2	structs . . . . .	192
10.2.1	Local includes . . . . .	192
10.3	structs . . . . .	192
10.4	defines . . . . .	193
10.5	externs . . . . .	197
10.6	local variables . . . . .	200
10.7	The Shared Code . . . . .	204
10.8	Code . . . . .	209
10.8.1	sigusr2Handler . . . . .	209
10.8.2	sigcldHandler . . . . .	209
10.8.3	cleanSocket . . . . .	209
10.8.4	initHash . . . . .	210
10.8.5	initPageStructs . . . . .	210
10.8.6	checkArguments . . . . .	210
10.8.7	makeServerConnections . . . . .	212
10.9	Condition Handling . . . . .	213
10.9.1	insertCond . . . . .	213
10.9.2	changeCond . . . . .	214
10.9.3	checkMemostack . . . . .	214
10.9.4	checkCondition . . . . .	215

10.10	Dialog Handling . . . . .	216
10.10.1	redrawWin . . . . .	216
10.10.2	mystrncpy . . . . .	216
10.10.3	incLineNumbers . . . . .	216
10.10.4	decLineNumbers . . . . .	217
10.10.5	decreaseLineNumbers . . . . .	217
10.10.6	overwriteBuffer . . . . .	217
10.10.7	moveSymForward . . . . .	219
10.10.8	clearCursorline . . . . .	220
10.10.9	insertBuffer . . . . .	220
10.10.10	addBufferToSym . . . . .	222
10.10.11	drawInputsymbol . . . . .	223
10.10.12	updateInputsymbol . . . . .	224
10.10.13	drawCursor . . . . .	224
10.10.14	moveCursorHome . . . . .	225
10.10.15	moveCursorEnd . . . . .	226
10.10.16	void moveCursorForward . . . . .	226
10.10.17	moveCursorDown . . . . .	227
10.10.18	moveCursorUp . . . . .	227
10.10.19	clearCursor . . . . .	228
10.10.20	moveCursorBackward . . . . .	229
10.10.21	moveRestBack . . . . .	229
10.10.22	deleteRestOfLine . . . . .	230
10.10.23	backOverEoln . . . . .	231
10.10.24	moveBackOneChar . . . . .	233
10.10.25	backOverChar . . . . .	235
10.10.26	deleteEoln . . . . .	235
10.10.27	deleteOneChar . . . . .	237
10.10.28	deleteChar . . . . .	238
10.10.29	oughEnter . . . . .	238
10.10.30	enterNewLine . . . . .	240
10.10.31	Dialog . . . . .	241
10.11	Format and Display a page . . . . .	244
10.11.1	showPage . . . . .	244
10.11.2	exposePage . . . . .	246
10.11.3	scrollPage . . . . .	247
10.11.4	pastePage . . . . .	248
10.12	Event Handling . . . . .	249
10.12.1	mainEventLoop . . . . .	249
10.12.2	handleEvent . . . . .	250
10.12.3	createWindow . . . . .	253
10.12.4	quitHyperDoc . . . . .	253
10.12.5	findPage . . . . .	254
10.12.6	downlink . . . . .	255
10.12.7	memolink . . . . .	255
10.12.8	killAxiomPage . . . . .	255

10.12.9	killPage	256
10.12.10	returnlink	256
10.12.11	hplink	257
10.12.12	showWindowLinkHandler	257
10.12.13	makeWindowLink	257
10.12.14	hideWindowLinkHandler	258
10.12.15	pasteButton	258
10.12.16	helpForHyperDoc	259
10.12.17	findButtonInList	259
10.12.18	getHyperLink	260
10.12.19	handleButton	260
10.12.20	exitHyperDoc	264
10.12.21	setWindow	265
10.12.22	clearExposures	266
10.12.23	getNewWindow	266
10.12.24	setCursor	269
10.12.25	changeCursor	269
10.12.26	handleMotionEvent	269
10.12.27	initCursorState	270
10.12.28	initCursorStates	270
10.12.29	makeBusyCursor	270
10.12.30	makeBusyCursors	271
10.12.31	HyperDocErrorHandler	271
10.12.32	setErrorHandlers	271
10.13	Line Extent Computation	272
10.13.1	computeInputExtent	272
10.13.2	computePunctuationExtent	272
10.13.3	computeWordExtent	274
10.13.4	computeVerbatimExtent	275
10.13.5	computeSpadsrctxtExtent	275
10.13.6	computeDashExtent	275
10.13.7	computeTextExtent	276
10.13.8	computeBeginItemsExtent	283
10.13.9	computeItemExtent	284
10.13.10	computeMitemExtent	284
10.13.11	endifExtent	284
10.13.12	computeIfcondExtent	285
10.13.13	computeCenterExtent	286
10.13.14	computeBfExtent	287
10.13.15	computeEmExtent	287
10.13.16	computeItExtent	287
10.13.17	computeRmExtent	288
10.13.18	computeButtonExtent	288
10.13.19	endbuttonExtent	289
10.13.20	computePastebuttonExtent	290
10.13.21	endpastebuttonExtent	290



10.13.22	computePasteExtent . . . . .	291
10.13.23	computeSpadcommandExtent . . . . .	291
10.13.24	computeSpadsrcExtent . . . . .	292
10.13.25	endSpadcommandExtent . . . . .	292
10.13.26	endSpadsrcExtent . . . . .	293
10.13.27	computeMboxExtent . . . . .	294
10.13.28	computeBoxExtent . . . . .	294
10.13.29	computeIrExtent . . . . .	295
10.13.30	computeImageExtent . . . . .	296
10.13.31	computeTableExtent . . . . .	296
10.13.32	computeTitleExtent . . . . .	297
10.13.33	computeHeaderExtent . . . . .	298
10.13.34	computeFooterExtent . . . . .	299
10.13.35	computeScrollingExtent . . . . .	299
10.13.36	startNewline . . . . .	300
10.13.37	enterNodes . . . . .	300
10.13.38	punctuationWidth . . . . .	301
10.13.39	inputStringWidth . . . . .	301
10.13.40	wordWidth . . . . .	302
10.13.41	verbatimWidth . . . . .	302
10.13.42	widthOfDash . . . . .	302
10.13.43	textWidth . . . . .	303
10.13.44	totalWidth . . . . .	307
10.13.45	nitExtents . . . . .	309
10.13.46	nitTitleExtents . . . . .	309
10.13.47	nitText . . . . .	310
10.13.48	extHeight . . . . .	310
10.13.49	extHeight1 . . . . .	310
10.13.50	maxX . . . . .	313
10.13.51	Kvalue . . . . .	315
10.13.52	railingSpace . . . . .	316
10.13.53	insertBitmapFile . . . . .	316
10.13.54	insertPixmapFile . . . . .	317
10.13.55	plh . . . . .	318
10.14	Handling forms . . . . .	318
10.14.1	computeFormPage . . . . .	319
10.14.2	windowWidth . . . . .	319
10.14.3	windowHeight . . . . .	319
10.14.4	formHeaderExtent . . . . .	320
10.14.5	formFooterExtent . . . . .	320
10.14.6	formScrollingExtent . . . . .	321
10.15	Managing the HyperDoc group stack . . . . .	321
10.15.1	popGroupStack . . . . .	321
10.15.2	pushGroupStack . . . . .	322
10.15.3	initGroupStack . . . . .	322
10.15.4	emTopGroup . . . . .	323

10.15.5	rmTopGroup . . . . .	323
10.15.6	lineTopGroup . . . . .	323
10.15.7	bfTopGroup . . . . .	324
10.15.8	ttTopGroup . . . . .	324
10.15.9	pushActiveGroup . . . . .	324
10.15.10	pushSpadGroup . . . . .	325
10.15.11	initTopGroup . . . . .	325
10.15.12	enterTopGroup . . . . .	325
10.15.13	copyGroupStack . . . . .	326
10.15.14	freeGroupStack . . . . .	326
10.16	Handle input, output, and Axiom communication . . . . .	327
10.16.1	makeRecord . . . . .	327
10.16.2	verifyRecord . . . . .	327
10.16.3	ht2Input . . . . .	328
10.16.4	makeInputFileName . . . . .	328
10.16.5	makePasteFileName . . . . .	329
10.16.6	makeTheInputFile . . . . .	329
10.16.7	makeInputFileFromPage . . . . .	330
10.16.8	strCopy . . . . .	331
10.16.9	inListAndNewer . . . . .	332
10.16.10	makeInputFileList . . . . .	333
10.16.11	printPasteLine . . . . .	333
10.16.12	getSpadOutput . . . . .	334
10.16.13	getGraphOutput . . . . .	334
10.16.14	sendCommand . . . . .	335
10.16.15	printPaste . . . . .	336
10.16.16	printGraphPaste . . . . .	336
10.17	X Window window initialization code . . . . .	337
10.17.1	initializeWindowSystem . . . . .	337
10.17.2	initTopWindow . . . . .	339
10.17.3	openFormWindow . . . . .	340
10.17.4	initFormWindow . . . . .	341
10.17.5	setNameAndIcon . . . . .	342
10.17.6	getBorderProperties . . . . .	342
10.17.7	openWindow . . . . .	343
10.17.8	setSizeHints . . . . .	344
10.17.9	getGCs . . . . .	346
10.17.10	loadFont . . . . .	347
10.17.11	ingItColorsAndFonts . . . . .	347
10.17.12	changeText . . . . .	351
10.17.13	getColor . . . . .	351
10.17.14	mergeDatabases . . . . .	352
10.17.15	isIt850 . . . . .	354
10.18	Handling user page interaction . . . . .	354
10.18.1	fillBox . . . . .	354
10.18.2	toggleInputBox . . . . .	355

10.18.3 toggleRadioBox . . . . .	355
10.18.4 clearRbs . . . . .	356
10.18.5 changeInputFocus . . . . .	356
10.18.6 nextInputFocus . . . . .	357
10.18.7 prevInputFocus . . . . .	357
10.18.8 returnItem . . . . .	358
10.18.9 deleteItem . . . . .	358
10.19 Manipulate the item stack . . . . .	359
10.19.1 pushItemStack . . . . .	359
10.19.2 clearItemStack . . . . .	359
10.19.3 popItemStack . . . . .	360
10.19.4 copyItemStack . . . . .	360
10.19.5 freeItemStack . . . . .	361
10.20 Keyboard handling . . . . .	361
10.20.1 handleKey . . . . .	361
10.20.2 getModifierMask . . . . .	364
10.20.3 initKeyin . . . . .	365
10.21 Handle page macros . . . . .	366
10.21.1 scanHyperDoc . . . . .	366
10.21.2 number . . . . .	367
10.21.3 loadMacro . . . . .	367
10.21.4 initParameterElem . . . . .	369
10.21.5 pushParameters . . . . .	369
10.21.6 popParameters . . . . .	370
10.21.7 parseMacro . . . . .	370
10.21.8 getParameterStrings . . . . .	371
10.21.9 parseParameters . . . . .	373
10.22 Memory management routines . . . . .	374
10.22.1 freeIfNonNULL . . . . .	374
10.22.2 allocHdWindow . . . . .	374
10.22.3 freeHdWindow . . . . .	375
10.22.4 allocNode . . . . .	375
10.22.5 freeNode . . . . .	376
10.22.6 allocIfnode . . . . .	379
10.22.7 allocCondnode . . . . .	380
10.22.8 freeCond . . . . .	380
10.22.9 allocPage . . . . .	380
10.22.10 freePage . . . . .	381
10.22.11 freePaste . . . . .	382
10.22.12 freePastebutton . . . . .	383
10.22.13 freePastearea . . . . .	383
10.22.14 freeString . . . . .	384
10.22.15 freeDepend . . . . .	384
10.22.16 dontFree . . . . .	384
10.22.17 freeLines . . . . .	385
10.22.18 freeInputItem . . . . .	385

10.22.19	freeInputList . . . . .	385
10.22.20	freeInputBox . . . . .	386
10.22.21	freeRadioBoxes . . . . .	386
10.22.22	allocInputline . . . . .	386
10.22.23	allocPasteNode . . . . .	387
10.22.24	allocPatchstore . . . . .	387
10.22.25	freePatch . . . . .	388
10.22.26	allocInputbox . . . . .	388
10.22.27	allocRbs . . . . .	388
10.22.28	allocButtonList . . . . .	389
10.22.29	freeButtonList . . . . .	389
10.22.30	resizeBuffer . . . . .	389
10.23	Page parsing routines . . . . .	390
10.23.1	PushMR . . . . .	390
10.23.2	PopMR . . . . .	390
10.23.3	loadPage . . . . .	391
10.23.4	displayPage . . . . .	391
10.23.5	formatPage . . . . .	392
10.23.6	parseFromString . . . . .	393
10.23.7	parseTitle . . . . .	393
10.23.8	parseHeader . . . . .	394
10.23.9	initParsePage . . . . .	394
10.23.10	initParsePatch . . . . .	395
10.23.11	parsePage . . . . .	395
10.23.12	parseHyperDoc . . . . .	396
10.23.13	parsePageFromSocket . . . . .	403
10.23.14	parsePageFromUnixfd . . . . .	404
10.23.15	startScrolling . . . . .	405
10.23.16	startFooter . . . . .	405
10.23.17	endAPage . . . . .	406
10.23.18	parseReplacepage . . . . .	407
10.23.19	windowEqual . . . . .	407
10.23.20	windowCode . . . . .	407
10.23.21	windowId . . . . .	407
10.23.22	readHtDb . . . . .	408
10.23.23	readHtFile . . . . .	409
10.23.24	makeLinkWindow . . . . .	412
10.23.25	makePasteWindow . . . . .	414
10.23.26	makeSpecialPage . . . . .	414
10.23.27	main . . . . .	415
10.23.28	addDependencies . . . . .	415
10.23.29	Number . . . . .	416
10.23.30	parserError . . . . .	417
10.23.31	getFilename . . . . .	417
10.23.32	getInputString . . . . .	418
10.23.33	getWhere . . . . .	419

10.23.34	findFp . . . . .	419
10.24	Handle InputString, SimpleBox, RadioBox input . . . . .	420
10.24.1	makeInputWindow . . . . .	420
10.24.2	makeBoxWindow . . . . .	421
10.24.3	initializeDefault . . . . .	421
10.24.4	parseInputstring . . . . .	422
10.24.5	parseSimplebox . . . . .	424
10.24.6	parseRadiobox . . . . .	425
10.24.7	addBoxToRbList . . . . .	427
10.24.8	checkOthers . . . . .	428
10.24.9	insertItem . . . . .	428
10.24.10	initPasteItem . . . . .	429
10.24.11	repasteItem . . . . .	429
10.24.12	currentItem . . . . .	430
10.24.13	alreadyThere . . . . .	430
10.24.14	parseRadioboxes . . . . .	431
10.25	Routines for paste-in areas . . . . .	432
10.25.1	parsePaste . . . . .	432
10.25.2	parsePastebutton . . . . .	434
10.25.3	parsePatch . . . . .	435
10.25.4	loadPatch . . . . .	437
10.26	parsing routines for node types . . . . .	438
10.26.1	parseIfcond . . . . .	438
10.26.2	parseCondnode . . . . .	440
10.26.3	parseHasreturnto . . . . .	441
10.26.4	parseNewcond . . . . .	441
10.26.5	parseSetcond . . . . .	441
10.26.6	parseBeginItems . . . . .	442
10.26.7	parseItem . . . . .	443
10.26.8	parseMitem . . . . .	443
10.26.9	parseVerbatim . . . . .	444
10.26.10	parseInputPix . . . . .	445
10.26.11	parseCenterline . . . . .	446
10.26.12	parseCommand . . . . .	446
10.26.13	parseButton . . . . .	447
10.26.14	parseSpadcommand . . . . .	448
10.26.15	parseSpadsrc . . . . .	449
10.26.16	parseEnv . . . . .	449
10.26.17	parseValue1 . . . . .	450
10.26.18	parseValue2 . . . . .	451
10.26.19	parseTable . . . . .	451
10.26.20	parseBox . . . . .	452
10.26.21	parseMbox . . . . .	453
10.26.22	parseFree . . . . .	453
10.26.23	parseHelp . . . . .	454
10.27	Reading bitmaps . . . . .	454

10.27.1	HTReadBitmapFile	454
10.27.2	readHot	457
10.27.3	readWandH	457
10.27.4	insertImageStruct	458
10.28	Scrollbar handling routines	458
10.28.1	makeScrollBarWindows	459
10.28.2	drawScroller3DEffects	461
10.28.3	showScrollBars	462
10.28.4	moveScroller	463
10.28.5	drawScrollLines	463
10.28.6	calculateScrollBarMeasures	464
10.28.7	linkScrollBars	465
10.28.8	scrollUp	466
10.28.9	scrollUpPage	467
10.28.10	scrollToFirstPage	467
10.28.11	scrollDown	467
10.28.12	scrollDownPage	468
10.28.13	scrollScroller	468
10.28.14	hideScrollBars	469
10.28.15	getScrollBarMinimumSize	470
10.28.16	h	470
10.28.17	changeWindowBackgroundPixmap	470
10.29	Display text object	471
10.29.1	showText	471
10.29.2	showLink	476
10.29.3	showPaste	477
10.29.4	showPastebutton	478
10.29.5	showInput	478
10.29.6	showSimpleBox	479
10.29.7	showSpadcommand	479
10.29.8	showImage	480
10.30	Axiom communication interface	481
10.30.1	issueSpadcommand	481
10.30.2	sendPile	482
10.30.3	issueDependentCommands	483
10.30.4	markAsExecuted	484
10.30.5	startUserBuffer	484
10.30.6	clearExecutionMarks	485
10.30.7	acceptMenuConnection	486
10.30.8	acceptMenuServerConnection	487
10.30.9	printToString	488
10.30.10	printToString1	488
10.30.11	issueServerCommand	493
10.30.12	issueServerpaste	494
10.30.13	issueUnixcommand	495
10.30.14	issueUnixlink	495

10.30.15	IssueUnixpaste . . . . .	496
10.30.16	ServiceSessionSocket . . . . .	496
10.30.17	SwitchFrames . . . . .	497
10.30.18	SendLispCommand . . . . .	497
10.30.19	EscapeString . . . . .	497
10.30.20	UnescapeString . . . . .	498
10.30.21	CloseClient . . . . .	498
10.30.22	PrintSourceToString . . . . .	499
10.30.23	PrintSourceToString1 . . . . .	499
10.31	Produce titlebar . . . . .	507
10.31.1	makeTitleBarWindows . . . . .	507
10.31.2	showTitleBar . . . . .	508
10.31.3	linkTitleBarWindows . . . . .	509
10.31.4	readTitleBarImages . . . . .	510
10.31.5	getTitleBarMinimumSize . . . . .	511
10.31.6	main . . . . .	511
<b>11</b>	<b>The htsearch script</b>	<b>515</b>
<b>12</b>	<b>The presea script</b>	<b>517</b>
12.1	token.h . . . . .	518
<b>13</b>	<b>The Bitmaps</b>	<b>523</b>
13.1	ht.icon . . . . .	523
13.2	exit.bitmap . . . . .	524
13.3	help2.bitmap . . . . .	524
13.4	return3.bitmap . . . . .	525
13.5	up3.bitmap . . . . .	526
13.6	noop.bitmap . . . . .	526
13.7	exit3d.bitmap . . . . .	527
13.8	help3d.bitmap . . . . .	528
13.9	home3d.bitmap . . . . .	528
13.10	up3d.bitmap . . . . .	529
13.11	noop3d.bitmap . . . . .	530
<b>14</b>	<b>Makefile</b>	<b>531</b>

## Volume 7.1: Axiom Hyperdoc

<b>1</b>	<b>Release Notes</b>	<b>1</b>
1.1	releasenotes.ht . . . . .	1
1.1.1	What is new in Axiom . . . . .	1
1.1.2	Online Information . . . . .	3
1.1.3	January 2012 Release Notes . . . . .	4
1.1.4	November 2011 Release Notes . . . . .	7
1.1.5	September 2011 Release Notes . . . . .	10
1.1.6	July 2011 Release Notes . . . . .	13
1.1.7	May 2011 Release Notes . . . . .	14
1.1.8	March 2011 Release Notes . . . . .	17
1.1.9	January 2011 Release Notes . . . . .	19
1.1.10	November 2010 Release Notes . . . . .	22
1.1.11	September 2010 Release Notes . . . . .	24
1.1.12	July 2010 Release Notes . . . . .	27
1.1.13	May 2010 Release Notes . . . . .	30
1.1.14	March 2010 Release Notes . . . . .	35
1.1.15	January 2010 Release Notes . . . . .	38
1.1.16	November 2009 Release Notes . . . . .	40
1.1.17	September 2009 Release Notes . . . . .	43
1.1.18	July 2009 Release Notes . . . . .	45
1.1.19	May 2009 Release Notes . . . . .	47
1.1.20	March 2009 Release Notes . . . . .	52
1.1.21	January 2009 Release Notes . . . . .	58
1.1.22	November 23, 2008 Release Notes . . . . .	63
1.1.23	September 23, 2008 Release Notes . . . . .	65
1.1.24	July 23, 2008 Release Notes . . . . .	68
1.1.25	May 27, 2008 Release Notes . . . . .	72
1.1.26	March 25, 2008 Release Notes . . . . .	73
1.1.27	January 25, 2008 Release Notes . . . . .	76
1.1.28	November 23, 2007 Release Notes . . . . .	82
1.1.29	Feature Complete Release Feb 2005 . . . . .	86
<b>2</b>	<b>Special hyperdoc pages</b>	<b>89</b>
2.1	util.ht . . . . .	89
2.1.1	Names of software and facilities . . . . .	89
2.1.2	Special hooks to Unix . . . . .	89
2.1.3	HyperDoc menu macros . . . . .	90
2.1.4	Bitmaps and bitmap manipulation macros . . . . .	91
2.1.5	HyperDoc button objects . . . . .	92
2.1.6	Standard HyperDoc button configurations . . . . .	92
2.1.7	HyperDoc graphics macros . . . . .	92
2.1.8	TeX and LaTeX compatibility macros . . . . .	93
2.1.9	Book and .ht page macros . . . . .	95



2.1.10	Browse macros . . . . .	98
2.1.11	Support for output and graph paste-ins . . . . .	99
2.1.12	Hook for including a local menu item on the rootpage . . . . .	99
2.1.13	Not Connected to Axiom . . . . .	100
2.1.14	Do You Really Want to Exit? . . . . .	100
2.1.15	Missing Page . . . . .	100
2.1.16	Something is Wrong . . . . .	101
2.1.17	Sorry! . . . . .	101
<b>3</b>	<b>Hyperdoc pages</b>	<b>103</b>
3.1	rootpage.ht . . . . .	103
3.1.1	Axiom HyperDoc Top Level . . . . .	103
3.1.2	Axiom – The Scientific Computation System . . . . .	105
3.1.3	System Commands . . . . .	106
3.1.4	Axiom Examples . . . . .	107
3.1.5	Axiom Reference . . . . .	109
3.1.6	NAG Documentation . . . . .	111
3.2	algebra.ht . . . . .	117
3.2.1	Abstract Algebra . . . . .	117
3.2.2	Number Theory . . . . .	118
3.3	alist.ht . . . . .	118
3.3.1	AssociationList . . . . .	118
3.4	array1.ht . . . . .	124
3.4.1	OneDimensionalArray . . . . .	124
3.5	array2.ht . . . . .	129
3.5.1	TwoDimensionalArray . . . . .	129
3.6	basic.ht . . . . .	141
3.6.1	Basic Commands . . . . .	141
3.6.2	Calculus . . . . .	142
3.7	bbtree.ht . . . . .	143
3.7.1	BalancedBinaryTree . . . . .	143
3.8	binary.ht . . . . .	149
3.8.1	BinaryExpansion . . . . .	149
3.9	bmcat.ht . . . . .	154
3.9.1	Bit Map Catalog . . . . .	154
3.10	bop.ht . . . . .	155
3.10.1	BasicOperator . . . . .	155
3.11	bstree.ht . . . . .	164
3.11.1	BinarySearchTree . . . . .	164
3.12	card.ht . . . . .	171
3.12.1	CardinalNumber . . . . .	171
3.13	carten.ht . . . . .	181
3.13.1	CartesianTensor . . . . .	181
3.14	cclass.ht . . . . .	207
3.14.1	CharacterClass . . . . .	207
3.15	char.ht . . . . .	214

3.15.1	Character	214
3.15.2	CliffordAlgebra	220
3.15.3	The Complex Numbers as a Clifford Algebra	221
3.15.4	The Quaternion Numbers as a Clifford Algebra	225
3.15.5	The Exterior Algebra on a Three Space	230
3.15.6	The Dirac Spin Algebra	236
3.16	complex.ht	240
3.16.1	Complex	240
3.17	contfrac.ht	248
3.17.1	ContinuedFraction	248
3.18	cphelp.ht	265
3.18.1	Control Panel Bits	265
3.19	cycles.ht	265
3.19.1	CycleIndicators	265
3.20	coverex.ht	290
3.20.1	Examples Of Axiom Commands	290
3.20.2	Differentiation	291
3.20.3	Integration	296
3.20.4	Laplace Transforms	303
3.20.5	Limits	306
3.20.6	Matrices	311
3.20.7	2-D Graphics	319
3.20.8	3-D Graphics	321
3.20.9	Series	323
3.20.10	Summations	328
3.21	decimal.ht	334
3.21.1	Decimal Expansion	334
3.22	derham.ht	338
3.22.1	DeRhamComplex	338
3.23	dfloat.ht	355
3.23.1	DoubleFloat	355
3.24	dmp.ht	361
3.24.1	DistributedMultivariatePoly	361
3.25	eq.ht	366
3.25.1	Equation	366
3.26	eqtbl.ht	372
3.26.1	EqTable	372
3.27	evalex.ht	375
3.27.1	Example of Standard Evaluation	375
3.27.2	Example of Standard Evaluation	376
3.28	exdiff.ht	377
3.28.1	Computing Derivatives	377
3.28.2	Derivatives of Functions of Several Variables	378
3.28.3	Derivatives of Higher Order	379
3.28.4	Multiple Derivatives I	380
3.28.5	Multiple Derivatives II	382

3.28.6	Derivatives of Functions Involving Formal Integrals . . . . .	382
3.28.7	Exit . . . . .	384
3.29	exlap.ht . . . . .	388
3.29.1	Laplace transform with a single pole . . . . .	388
3.29.2	Laplace transform of a trigonometric function . . . . .	388
3.29.3	Laplace transform requiring a definite integration . . . . .	389
3.29.4	Laplace transform of exponentials . . . . .	390
3.29.5	Laplace transform of an exponential integral . . . . .	391
3.29.6	Laplace transform of special functions . . . . .	392
3.30	exint.ht . . . . .	392
3.30.1	Integral of a Rational Function . . . . .	392
3.30.2	Integral of a Rational Function with a Real Parameter . . . . .	395
3.30.3	Integral of a Rational Function with a Complex Parameter . . . . .	396
3.30.4	Two Similar Integrands Producing Very Different Results . . . . .	396
3.30.5	An Integral Which Does Not Exist . . . . .	398
3.30.6	A Trigonometric Function of a Quadratic . . . . .	399
3.30.7	Integrating a Function with a Hidden Algebraic Relation . . . . .	400
3.30.8	Details for integrating a function with a Hidden Algebraic Relation . .	401
3.30.9	An Integral Involving a Root of a Transcendental Function . . . . .	402
3.30.10	An Integral of a Non-elementary Function . . . . .	403
3.31	exlimit.ht . . . . .	403
3.31.1	Computing Limits . . . . .	403
3.31.2	Limits of Functions with Parameters . . . . .	404
3.31.3	One-sided Limits . . . . .	405
3.31.4	Two-sided Limits . . . . .	406
3.31.5	Limits at Infinity . . . . .	408
3.31.6	Real Limits vs. Complex Limits . . . . .	409
3.31.7	Complex Limits at Infinity . . . . .	410
3.32	exmatrix.ht . . . . .	412
3.32.1	Basic Arithmetic Operations on Matrices . . . . .	412
3.32.2	Constructing new Matrices . . . . .	415
3.32.3	Trace of a Matrix . . . . .	419
3.32.4	Determinant of a Matrix . . . . .	419
3.32.5	Inverse of a Matrix . . . . .	420
3.32.6	Rank of a Matrix . . . . .	421
3.33	expr.ht . . . . .	422
3.33.1	Expression . . . . .	422
3.34	explot2d.ht . . . . .	435
3.34.1	Plotting Functions of One Variable . . . . .	435
3.34.2	Plotting Parametric Curves . . . . .	435
3.34.3	Plotting Using Polar Coordinates . . . . .	436
3.34.4	Plotting Plane Algebraic Curves . . . . .	437
3.35	explot3d.ht . . . . .	437
3.35.1	Plotting Functions of Two Variables . . . . .	437
3.35.2	Plotting Parametric Surfaces . . . . .	438
3.35.3	Plotting Parametric Curves . . . . .	439

3.36	expose.ht . . . . .	440
3.36.1	Exposure . . . . .	440
3.36.2	System Defined Exposure Groups . . . . .	441
3.36.3	What is an Exposure Group? . . . . .	442
3.36.4	Details on Exposure . . . . .	443
3.37	exseries.ht . . . . .	443
3.37.1	Converting Expressions to Series . . . . .	443
3.37.2	Manipulating Power Series . . . . .	445
3.37.3	Functions on Power Series . . . . .	447
3.37.4	Substituting Numerical Values in Power Series . . . . .	448
3.38	exsum.ht . . . . .	450
3.38.1	Summing the Entries of a List I . . . . .	450
3.38.2	Summing the Entries of a List II . . . . .	451
3.38.3	Approximating $e$ . . . . .	452
3.38.4	Closed Form Summations . . . . .	453
3.38.5	Sums of Cubes . . . . .	454
3.38.6	Sums of Polynomials . . . . .	456
3.38.7	Sums of General Functions . . . . .	457
3.38.8	Infinite Sums . . . . .	458
3.39	farray.ht . . . . .	458
3.39.1	FlexibleArray . . . . .	458
3.40	file.ht . . . . .	466
3.40.1	File . . . . .	466
3.41	float.ht . . . . .	473
3.41.1	Float . . . . .	473
3.41.2	Introduction to Float . . . . .	474
3.41.3	Conversion Functions . . . . .	476
3.41.4	Output Functions . . . . .	484
3.41.5	An Example: Determinant of a Hilbert Matrix . . . . .	488
3.41.6	Expanding Factored Objects . . . . .	507
3.41.7	Arithmetic with Factored Objects . . . . .	509
3.41.8	Creating New Factored Objects . . . . .	516
3.41.9	Factored Objects with Variables . . . . .	520
3.42	fr2.ht . . . . .	523
3.42.1	FactoredFunctions2 . . . . .	523
3.43	frac.ht . . . . .	527
3.43.1	Fraction . . . . .	527
3.44	fparfrac.ht . . . . .	533
3.44.1	FullPartialFracExpansion . . . . .	533
3.45	function.ht . . . . .	544
3.45.1	Functions in Axiom . . . . .	544
3.45.2	Rational Functions . . . . .	545
3.45.3	Algebraic Functions . . . . .	548
3.45.4	Elementary Functions . . . . .	551
3.45.5	Simplification . . . . .	552
3.46	gbf.ht . . . . .	559

3.46.1	GroebnerFactorizationPkg . . . . .	559
3.47	gloss.ht . . . . .	563
3.47.1	Glossary . . . . .	563
3.48	graphics.ht . . . . .	585
3.48.1	Graphics . . . . .	585
3.48.2	Graphics Examples . . . . .	586
3.48.3	Assorted Graphics Examples . . . . .	587
3.48.4	Three Dimensional Graphics . . . . .	589
3.48.5	Functions of One Variable . . . . .	594
3.48.6	Parametric Curves . . . . .	596
3.48.7	Polar Coordinates . . . . .	598
3.48.8	Implicit Curves . . . . .	600
3.48.9	Lists of Points . . . . .	603
3.48.10	Two Dimensional Graphics . . . . .	626
3.48.11	Functions of One Variable . . . . .	627
3.48.12	Parametric Curves . . . . .	629
3.48.13	Polar Coordinates . . . . .	632
3.48.14	Implicit Curves . . . . .	634
3.48.15	Lists of Points . . . . .	635
3.48.16	Representation Theory . . . . .	667
3.48.17	Group Theory . . . . .	668
3.49	gstbl.ht . . . . .	669
3.49.1	GeneralSparseTable . . . . .	669
3.50	heap.ht . . . . .	673
3.50.1	Heap . . . . .	673
3.51	hexadec.ht . . . . .	675
3.51.1	HexadecimalExpansion . . . . .	675
3.52	int.ht . . . . .	679
3.52.1	Integer . . . . .	679
3.52.2	Basic Functions . . . . .	681
3.52.3	Primes and Factorization . . . . .	695
3.52.4	Some Number Theoretic Functions . . . . .	699
3.53	intheory.ht . . . . .	705
3.53.1	IntegerNumberTheoryFunctions . . . . .	705
3.54	kafle.ht . . . . .	717
3.54.1	KeyedAccessFile . . . . .	717
3.55	kernel.ht . . . . .	726
3.55.1	Kernel . . . . .	726
3.56	lazm3pk.ht . . . . .	735
3.56.1	LazardSetSolvingPackage . . . . .	735
3.57	lexp.ht . . . . .	761
3.57.1	LieExponentials . . . . .	761
3.58	lextripk.ht . . . . .	767
3.58.1	LexTriangularPackage . . . . .	767
3.59	lib.ht . . . . .	823
3.59.1	Library . . . . .	823

3.60	link.ht	827
3.60.1	The Axiom Link to NAG Software	827
3.60.2	Use of the Link from HyperDoc	828
3.60.3	C02 Zeros of Polynomials	829
3.60.4	C05 Roots of One or More Transcendental Equations	830
3.60.5	C06 Summation of Series	830
3.60.6	D01 Quadrature	832
3.60.7	D02 Ordinary Differential Equations	834
3.60.8	D03 Partial Differential Equations	835
3.60.9	E01 Interpolation	836
3.60.10	E02 Curve and Surface Fitting	837
3.60.11	E04 Minimizing or Maximizing a Function	839
3.60.12	F01 Matrix Operations - Including Inversion	840
3.60.13	F02 Eigenvalues and Eigenvectors	841
3.60.14	F04 Simultaneous Linear Equations	843
3.60.15	F07 Linear Equations (LAPACK)	845
3.60.16	S – Approximations of Special Functions	846
3.61	list.ht	849
3.61.1	List	849
3.61.2	Creating Lists	850
3.61.3	Accessing List Elements	852
3.61.4	Changing List Elements	858
3.61.5	Other Functions	862
3.61.6	Dot, Dot	865
3.62	lodo.ht	867
3.62.1	LinearOrdinaryDifferentialOperator	867
3.62.2	Differential Operators with Series Coefficients	867
3.63	lodo1.ht	877
3.63.1	LinearOrdinaryDifferentialOperator1	877
3.63.2	Differential Operators with Rational Function Coefficients	878
3.64	lodo2.ht	888
3.64.1	LinearOrdinaryDifferentialOperator2	888
3.64.2	Differential Operators with Constant Coefficients	889
3.64.3	Differential Operators with Matrix Coefficients Operating on Vectors	894
3.65	lpoly.ht	903
3.65.1	LiePolynomial	903
3.66	magma.ht	924
3.66.1	Magma	924
3.67	man0.ht	934
3.67.1	Reference Search	934
3.67.2	Lisp Functions	935
3.67.3	Axiom Browser	945
3.67.4	The Hyperdoc Browse Facility	946
3.68	mapping.ht	947
3.68.1	Domain <b>Mapping</b> (T,S,...)	947
3.68.2	Domain Constructor <b>Mapping</b>	947

3.69	mappkg1.ht . . . . .	948
3.69.1	MappingPackage1 . . . . .	948
3.70	mset.ht . . . . .	961
3.70.1	MultiSet . . . . .	961
3.71	matrix.ht . . . . .	966
3.71.1	Matrix . . . . .	966
3.71.2	Creating Matrices . . . . .	967
3.71.3	Operations on Matrices . . . . .	979
3.72	mkfunc.ht . . . . .	989
3.72.1	MakeFunction . . . . .	989
3.73	mpoly.ht . . . . .	994
3.73.1	MultivariatePolynomial . . . . .	994
3.74	newuser.ht . . . . .	1000
3.74.1	No More Help :-(. . . . .	1000
3.74.2	You Tried It! . . . . .	1001
3.75	none.ht . . . . .	1001
3.75.1	None . . . . .	1001
3.76	numbers.ht . . . . .	1004
3.76.1	Axiom Number Types . . . . .	1004
3.76.2	Fraction . . . . .	1006
3.76.3	Rational Number . . . . .	1008
3.76.4	Integers . . . . .	1012
3.76.5	Integer Examples . . . . .	1017
3.76.6	Integer Example Proof . . . . .	1019
3.76.7	Integer Problems . . . . .	1020
3.76.8	Integer Problem Proof . . . . .	1021
3.76.9	Solution to Problem #1 . . . . .	1021
3.76.10	Solution to Problem #2 . . . . .	1025
3.77	oct.ht . . . . .	1027
3.77.1	Octonion . . . . .	1027
3.78	odpol.ht . . . . .	1036
3.78.1	OrderlyDifferentialPolynomial . . . . .	1036
3.79	op.ht . . . . .	1054
3.79.1	Operator . . . . .	1054
3.80	ovar.ht . . . . .	1065
3.80.1	OrderedVariableList . . . . .	1065
3.81	perman.ht . . . . .	1068
3.81.1	Permanent . . . . .	1068
3.82	pfr.ht . . . . .	1071
3.82.1	PartialFraction . . . . .	1071
3.83	poly.ht . . . . .	1078
3.83.1	Polynomials . . . . .	1078
3.83.2	The Specific Polynomial Types . . . . .	1079
3.83.3	Basic Operations On Polynomials . . . . .	1080
3.83.4	Polynomial Evaluation and Substitution . . . . .	1087
3.83.5	Greatest Common Divisors, Resultants, and Discriminants . . . . .	1091

3.83.6	Roots of Polynomials . . . . .	1093
3.84	poly1.ht . . . . .	1093
3.84.1	Polynomial . . . . .	1093
3.85	quat.ht . . . . .	1117
3.85.1	Quaternion . . . . .	1117
3.86	radix.ht . . . . .	1123
3.86.1	RadixExpansion . . . . .	1123
3.87	reclos.ht . . . . .	1132
3.87.1	RealClosure . . . . .	1132
3.88	sregset.ht . . . . .	1227
3.88.1	SquareFreeRegularTriangularSet . . . . .	1227
3.89	stbl.ht . . . . .	1239
3.89.1	SparseTable . . . . .	1239
3.90	stream.ht . . . . .	1243
3.90.1	Stream . . . . .	1243
3.91	string.ht . . . . .	1249
3.91.1	String . . . . .	1249
3.92	strtbl.ht . . . . .	1264
3.92.1	StringTable . . . . .	1264
3.93	symbol.ht . . . . .	1267
3.93.1	Symbol . . . . .	1267
3.94	table.ht . . . . .	1278
3.94.1	Table . . . . .	1278
3.95	textfile.ht . . . . .	1287
3.95.1	TextFile . . . . .	1287
3.96	topics.ht . . . . .	1293
3.96.1	Axiom Topics . . . . .	1293
3.96.2	Solving Equations . . . . .	1295
3.96.3	Linear Algebra . . . . .	1296
3.96.4	Calculus . . . . .	1298
3.97	type.ht . . . . .	1299
3.97.1	Category <b>Type</b> . . . . .	1299
3.98	union.ht . . . . .	1299
3.98.1	Domain <b>Union(a:A,...,b:B)</b> . . . . .	1299
3.98.2	Domain Constructor <b>Union</b> . . . . .	1300
3.98.3	Domain <b>Union(A,...,B)</b> . . . . .	1301
3.98.4	Domain Constructor <b>Union</b> . . . . .	1302
3.99	uniseg.ht . . . . .	1302
3.99.1	UniversalSegment . . . . .	1302
3.100up	ht . . . . .	1307
3.100.1	UnivariatePolynomial . . . . .	1307
3.101oreup	ht . . . . .	1325
3.101.1	UnivariateSkewPolynomial . . . . .	1325
3.102vector	ht . . . . .	1331
3.102.1	Vector . . . . .	1331
3.103void	ht . . . . .	1337



3.103.1 Void . . . . .	1337
3.104wutset.ht . . . . .	1340
3.104.1 WuWenTsunTriangularSet . . . . .	1340
3.105xmpexp.ht . . . . .	1349
3.105.1 Some Examples of Domains and Packages . . . . .	1349
3.106xpbwpoly.ht . . . . .	1354
3.106.1 XPBWPolynomial . . . . .	1354
3.107xpoly.ht . . . . .	1375
3.107.1 XPolynomial . . . . .	1375
3.108xpr.ht . . . . .	1382
3.108.1 XPolynomialRing . . . . .	1382
3.109zlindep.ht . . . . .	1443
3.109.1 IntegerLinearDependence . . . . .	1443
<b>4 Users Guide Pages (ug.ht)</b>	<b>1449</b>
4.0.2 Users Guide . . . . .	1450
<b>5 Users Guide Chapter 0 (ug00.ht)</b>	<b>1453</b>
5.0.3 What's New for May 2008 . . . . .	1453
5.0.4 New polynomial domains and algorithms . . . . .	1454
5.0.5 Enhancements to HyperDoc and Graphics . . . . .	1455
5.0.6 Enhancements to NAGLink . . . . .	1456
5.0.7 Enhancements to the Lisp system . . . . .	1456
<b>6 Users Guide Chapter 1 (ug01.ht)</b>	<b>1463</b>
6.0.8 An Overview of Axiom . . . . .	1463
6.0.9 Starting Up and Winding Down . . . . .	1464
6.0.10 Clef . . . . .	1467
6.0.11 Typographic Conventions . . . . .	1468
6.0.12 The Axiom Language . . . . .	1469
6.0.13 Arithmetic Expressions . . . . .	1470
6.0.14 Previous Results . . . . .	1472
6.0.15 Some Types . . . . .	1474
6.0.16 Symbols, Variables, Assignments, and Declarations . . . . .	1477
6.0.17 Conversion . . . . .	1483
6.0.18 Calling Functions . . . . .	1485
6.0.19 Some Predefined Macros . . . . .	1488
6.0.20 Long Lines . . . . .	1489
6.0.21 Comments . . . . .	1490
6.0.22 Graphics . . . . .	1490
6.0.23 Numbers . . . . .	1493
6.0.24 Data Structures . . . . .	1512
6.0.25 Expanding to Higher Dimensions . . . . .	1528
6.0.26 Writing Your Own Functions . . . . .	1533
6.0.27 Solution of Equations . . . . .	1581
6.0.28 Records . . . . .	1623

6.0.29	Subdomains Again . . . . .	1654
6.0.30	Package Calling and Target Types . . . . .	1661
6.0.31	Resolving Types . . . . .	1670
6.0.32	Exposing Domains and Packages . . . . .	1673
6.0.33	Commands for Snooping . . . . .	1677
<b>7</b>	<b>Users Guide Chapter 3 (ug03.ht)</b>	<b>1683</b>
7.0.34	Using Hyperdoc . . . . .	1683
7.0.35	Headings . . . . .	1684
7.0.36	Key Definitions . . . . .	1685
7.0.37	Scroll Bars . . . . .	1686
7.0.38	Input Areas . . . . .	1687
7.0.39	Radio Buttons and Toggles . . . . .	1689
7.0.40	Search Strings . . . . .	1690
7.0.41	Logical Searches . . . . .	1691
7.0.42	Example Pages . . . . .	1692
7.0.43	X Window Resources for Hyperdoc . . . . .	1693
<b>8</b>	<b>Users Guide Chapter 4 (ug04.ht)</b>	<b>1697</b>
8.0.44	Input Files and Output Styles . . . . .	1697
8.0.45	Input Files . . . . .	1698
8.0.46	The .axiom.input File . . . . .	1700
8.0.47	Common Features of Using Output Formats . . . . .	1701
8.0.48	Monospace 2D Mathematical Format . . . . .	1704
8.0.49	HTML Format . . . . .	1718
8.0.50	Immediate and Delayed Assignments . . . . .	1720
8.0.51	Blocks . . . . .	1728
8.0.52	if-then-else . . . . .	1737
8.0.53	Loops . . . . .	1740
8.0.54	Compiling vs. Interpreting Loops . . . . .	1742
8.0.55	return in Loops . . . . .	1742
8.0.56	break in Loops . . . . .	1746
8.0.57	break vs. => in Loop Bodies . . . . .	1749
8.0.58	More Examples of break . . . . .	1750
8.0.59	iterate in Loops . . . . .	1758
8.0.60	while Loops . . . . .	1759
8.0.61	for Loops . . . . .	1766
8.0.62	for i in n..m repeat . . . . .	1767
8.0.63	for i in n..m by s repeat . . . . .	1771
8.0.64	for i in n.. repeat . . . . .	1772
8.0.65	for x in l repeat . . . . .	1773
8.0.66	“Such that” Predicates . . . . .	1776
8.0.67	Parallel Iteration . . . . .	1778
8.0.68	Creating Lists and Streams with Iterators . . . . .	1784
8.0.69	Addendum: Appending a Graph to a Viewport Window Containing a Graph . . . . .	1983

8.0.70	Three-Dimensional Graphics . . . . .	1986
8.0.71	Plotting Three-Dimensional Functions of Two Variables . . . . .	1987
8.0.72	Plotting Three-Dimensional Parametric Space Curves . . . . .	1989
8.0.73	Plotting 3D Parametric Surfaces . . . . .	1992
8.0.74	Three-Dimensional Options . . . . .	1996
8.0.75	The makeObject Command . . . . .	2006
8.0.76	Building 3D Objects From Primitives . . . . .	2008
8.0.77	Coordinate System Transformations . . . . .	2021
8.0.78	Three-Dimensional Clipping . . . . .	2028
8.0.79	Three-Dimensional Control-Panel . . . . .	2030
8.0.80	Operations for Three-Dimensional Graphics . . . . .	2035
8.0.81	Customization using .Xdefaults . . . . .	2042
<b>9</b>	<b>Users Guide Chapter 8 (ug08.ht)</b>	<b>2045</b>
9.0.82	Advanced Problem Solving . . . . .	2045
9.0.83	Numeric Functions . . . . .	2047
9.0.84	Polynomial Factorization . . . . .	2069
9.0.85	Integer and Rational Number Coefficients . . . . .	2070
9.0.86	Finite Field Coefficients . . . . .	2072
9.0.87	Simple Algebraic Extension Field Coefficients . . . . .	2074
9.0.88	Factoring Rational Functions . . . . .	2079
9.0.89	Manipulating Symbolic Roots of a Polynomial . . . . .	2080
9.0.90	Using a Single Root of a Polynomial . . . . .	2081
9.0.91	Using All Roots of a Polynomial . . . . .	2085
9.0.92	Computation of Eigenvalues and Eigenvectors . . . . .	2091
9.0.93	Solution of Linear and Polynomial Equations . . . . .	2098
9.0.94	Solution of Systems of Linear Equations . . . . .	2099
9.0.95	Solution of a Single Polynomial Equation . . . . .	2103
9.0.96	Solution of Systems of Polynomial Equations . . . . .	2108
9.0.97	Limits . . . . .	2113
9.0.98	Laplace Transforms . . . . .	2120
9.0.99	Integration . . . . .	2125
9.0.100	Working with Power Series . . . . .	2132
9.0.101	Creation of Power Series . . . . .	2134
9.0.102	Coefficients of Power Series . . . . .	2140
9.0.103	Power Series Arithmetic . . . . .	2143
9.0.104	Functions on Power Series . . . . .	2146
9.0.105	Converting to Power Series . . . . .	2154
9.0.106	Power Series from Formulas . . . . .	2162
9.0.107	Substituting Numerical Values in Power Series . . . . .	2169
9.0.108	Example: Bernoulli Polynomials and Sums of Powers . . . . .	2171
9.0.109	Solution of Differential Equations . . . . .	2179
9.0.110	Closed-Form Solutions of Linear Differential Equations . . . . .	2180
9.0.111	Closed-Form Solutions of Non-Linear DEs . . . . .	2188
9.0.112	Power Series Solutions of Differential Equations . . . . .	2198
9.0.113	Finite Fields . . . . .	2203

9.0.114	Modular Arithmetic and Prime Fields . . . . .	2205
9.0.115	Extensions of Finite Fields . . . . .	2214
9.0.116	Irreducible Mod Polynomial Representations . . . . .	2217
9.0.117	Cyclic Group Representations . . . . .	2226
9.0.118	Normal Basis Representations . . . . .	2232
9.0.119	Conversion Operations for Finite Fields . . . . .	2240
9.0.120	Utility Operations for Finite Fields . . . . .	2248
9.0.121	Primary Decomposition of Ideals . . . . .	2265
9.0.122	Computation of Galois Groups . . . . .	2274
9.0.123	Non-Associative Algebras and Genetic Laws . . . . .	2293
<b>10</b>	<b>Users Guide Chapter 10 (ug10.ht)</b>	<b>2305</b>
10.0.124	Interactive Programming . . . . .	2305
10.0.125	Drawing Ribbons Interactively . . . . .	2306
10.0.126	A Ribbon Program . . . . .	2312
10.0.127	Coloring and Positioning Ribbons . . . . .	2315
10.0.128	Points, Lines, and Curves . . . . .	2316
10.0.129	Browse . . . . .	2393
10.0.130	Representation . . . . .	2394
10.0.131	Multiple Representations . . . . .	2395
10.0.132	Add Domain . . . . .	2397
10.0.133	Defaults . . . . .	2398
10.0.134	Origins . . . . .	2399
10.0.135	Short Forms . . . . .	2400
10.0.136	Example 1: Clifford Algebra . . . . .	2401
10.0.137	Example 2: Building A Query Facility . . . . .	2404
10.0.138	A Little Query Language . . . . .	2405
10.0.139	The Database Constructor . . . . .	2408
10.0.140	Query Equations . . . . .	2411
10.0.141	DataLists . . . . .	2412
10.0.142	Index Cards . . . . .	2413
10.0.143	Creating a Database . . . . .	2414
10.0.144	Putting It All Together . . . . .	2415
10.0.145	Example Queries . . . . .	2416
<b>11</b>	<b>Users Guide Chapter 14 (ug14.ht)</b>	<b>2429</b>
11.0.146	Browse . . . . .	2429
11.0.147	The Front Page: Searching the Library . . . . .	2430
11.0.148	The Constructor Page . . . . .	2432
11.0.149	Constructor Page Buttons . . . . .	2434
11.0.150	Cross Reference . . . . .	2436
11.0.151	Views Of Constructors . . . . .	2440
11.0.152	Giving Parameters to Constructors . . . . .	2442
11.0.153	Miscellaneous Features of Browse . . . . .	2443
11.0.154	The Description Page for Operations . . . . .	2444
11.0.155	Views of Operations . . . . .	2445

11.0.15	Capitalization Convention . . . . .	2448
<b>12</b>	<b>Users Guide Chapter 15 (ug15.ht)</b>	<b>2451</b>
12.0.15	What's New in Axiom Version 2.0 . . . . .	2451
12.0.15	Important Things to Read First . . . . .	2452
12.0.15	The NAG Library Link . . . . .	2452
12.0.16	Interpreting NAG Documentation . . . . .	2453
12.0.16	Using the Link . . . . .	2456
12.0.16	Providing values for Argument Subprograms . . . . .	2459
12.0.16	General Fortran-generation utilities in Axiom . . . . .	2463
12.0.16	Some technical information . . . . .	2488
12.0.16	Interactive Front-end and Language . . . . .	2489
12.0.16	Library . . . . .	2490
12.0.16	HyperDoc . . . . .	2492
12.0.16	Documentation . . . . .	2493
<b>13</b>	<b>Users Guide Chapter 16 (ug16.ht)</b>	<b>2495</b>
13.0.16	Axiom System Commands . . . . .	2496
13.0.17	Introduction . . . . .	2498
13.0.17	1 abbreviation . . . . .	2500
13.0.17	2 boot . . . . .	2502
13.0.17	3 cd . . . . .	2503
13.0.17	4 close . . . . .	2504
13.0.17	5 clear . . . . .	2505
13.0.17	6 compile . . . . .	2507
13.0.17	7 display . . . . .	2510
13.0.17	8 edit . . . . .	2512
13.0.17	9 fin . . . . .	2513
13.0.18	0 frame . . . . .	2514
13.0.18	1 help . . . . .	2516
13.0.18	2 history . . . . .	2517
13.0.18	3 library . . . . .	2521
13.0.18	4 lisp . . . . .	2523
13.0.18	5 load . . . . .	2524
13.0.18	6 ltrace . . . . .	2524
13.0.18	7 pquit . . . . .	2525
13.0.18	8 quit . . . . .	2527
13.0.18	9 read . . . . .	2528
13.0.19	0 set . . . . .	2529
13.0.19	1 show . . . . .	2531
13.0.19	2 spool . . . . .	2532
13.0.19	3 synonym . . . . .	2533
13.0.19	4 system . . . . .	2534
13.0.19	5 trace . . . . .	2536
13.0.19	6 undo . . . . .	2542
13.0.19	7 what . . . . .	2544

<b>14 Users Guide Chapter 21 (ug21.ht)</b>	<b>2547</b>
14.0.198 Programs for Axiom Images . . . . .	2547
14.0.199 images1.input . . . . .	2548
14.0.200 images2.input . . . . .	2549
14.0.201 images3.input . . . . .	2549
14.0.202 images5.input . . . . .	2550
14.0.203 images6.input . . . . .	2552
14.0.204 images7.input . . . . .	2553
14.0.205 images8.input . . . . .	2554
14.0.206 conformal.input . . . . .	2555
14.0.207 knot.input . . . . .	2559
14.0.208 tube.input . . . . .	2559
14.0.209 lhtri.input . . . . .	2562
14.0.210 tetra.input . . . . .	2563
14.0.211 Antoine.input . . . . .	2565
14.0.212 cherk.input . . . . .	2566
 <b>15 Hypertext Language Pages</b>	 <b>2569</b>
15.0.213 Creating Hyperdoc Pages . . . . .	2569
15.1 htxadvpage1.ht . . . . .	2570
15.1.1 Input Areas . . . . .	2570
15.1.2 HTXAdvPage1xPatch1 patch . . . . .	2571
15.1.3 HTXAdvPage1xPatch1A patch . . . . .	2571
15.1.4 HTXAdvPage1xPatch2 patch . . . . .	2572
15.1.5 HTXAdvPage1xPatch2A patch . . . . .	2572
15.2 htxadvpage2.ht . . . . .	2573
15.2.1 Radio buttons . . . . .	2573
15.3 htxadvpage3.ht . . . . .	2576
15.3.1 Macros . . . . .	2576
15.4 htxadvpage4.ht . . . . .	2577
15.4.1 Patch and Paste . . . . .	2577
15.4.2 patch1 patch . . . . .	2580
15.4.3 Patch1 patch . . . . .	2580
15.4.4 Patch2 patch . . . . .	2581
15.5 htxadvpage5.ht . . . . .	2581
15.5.1 Axiom paste-ins . . . . .	2581
15.6 htxadvpage6.ht . . . . .	2584
15.6.1 Miscellaneous . . . . .	2584
15.6.2 HTXAdvPage6xPatch1 patch . . . . .	2586
15.6.3 HTXAdvPage6xPatch1A patch . . . . .	2586
15.6.4 HTXAdvPage6xPatch2 patch . . . . .	2586
15.6.5 HTXAdvPage6xPatch2A patch . . . . .	2587
15.6.6 HTXAdvPage6xPatch3 patch . . . . .	2587
15.6.7 HTXAdvPage6xPatch3A patch . . . . .	2587
15.7 htxadvtoppage.ht . . . . .	2588
15.7.1 Advanced features in Hyperdoc . . . . .	2588

15.8	htxformatpage1.ht	2589
15.8.1	Using the special characters	2589
15.8.2	HTXFormatPage1xPatch1 patch	2590
15.8.3	HTXFormatPage1xPatch2 patch	2590
15.9	htxformatpage2.ht	2591
15.9.1	Formatting without commands	2591
15.9.2	HTXFormatPage2xPatch1 patch	2592
15.9.3	HTXFormatPage2xPatch2 patch	2593
15.9.4	HTXFormatPage2xPatch2A patch	2593
15.9.5	HTXFormatPage2xPatch3 patch	2594
15.9.6	HTXFormatPage2xPatch3A patch	2594
15.9.7	HTXFormatPage2xPatch4 patch	2595
15.9.8	HTXFormatPage2xPatch4A patch	2595
15.10	htxformatpage3.ht	2595
15.10.1	Using different fonts	2595
15.10.2	HTXFormatPage3xPatch1 patch	2597
15.10.3	HTXFormatPage3xPatch2 patch	2598
15.10.4	HTXFormatPage3xPatch3 patch	2598
15.10.5	HTXFormatPage3xPatch4 patch	2599
15.11	htxformatpage4.ht	2599
15.11.1	Indentation	2599
15.11.2	HTXFormatPage4xPatch1 patch	2602
15.11.3	HTXFormatPage4xPatch1A patch	2602
15.11.4	HTXFormatPage4xPatch2 patch	2602
15.11.5	HTXFormatPage4xPatch2A patch	2603
15.11.6	HTXFormatPage4xPatch3 patch	2603
15.11.7	HTXFormatPage4xPatch3A patch	2604
15.11.8	HTXFormatPage4xPatch4 patch	2604
15.11.9	HTXFormatPage4xPatch5 patch	2605
15.11.10	HTXFormatPage4xPatch5A patch	2605
15.12	htxformatpage5.ht	2606
15.12.1	Creating Lists and Tables	2606
15.12.2	HTXFormatPage5xPatch1 patch	2608
15.12.3	HTXFormatPage5xPatch1A patch	2609
15.12.4	HTXFormatPage5xPatch2 patch	2609
15.12.5	HTXFormatPage5xPatch2A patch	2610
15.12.6	HTXFormatPage5xPatch3 patch	2610
15.12.7	HTXFormatPage5xPatch3A patch	2611
15.13	htxformatpage6	2611
15.13.1	Boxes and Lines	2611
15.13.2	HTXFormatPage6xPatch1 patch	2612
15.13.3	HTXFormatPage6xPatch2 patch	2613
15.14	htxformatpage7	2613
15.14.1	Micro-Spacing	2613
15.14.2	HTXFormatPage7xPatch1 patch	2615
15.14.3	HTXFormatPage7xPatch2 patch	2616

15.14.4 HTXFormatPage7xPatch2A patch . . . . .	2616
15.14.5 HTXFormatPage7xPatch3 patch . . . . .	2616
15.14.6 HTXFormatPage7xPatch3A patch . . . . .	2617
15.15htxformatpage8 . . . . .	2618
15.15.1 Bitmaps and Images . . . . .	2618
15.15.2 HTXFormatPage8xPatch1 patch . . . . .	2619
15.15.3 HTXFormatPage8xPatch2 patch . . . . .	2620
15.15.4 HTXFormatPage8xPatch2A patch . . . . .	2620
15.16htxformattoppage.ht . . . . .	2620
15.16.1 Formatting in Hyperdoc . . . . .	2620
15.17htxintropage1.ht . . . . .	2621
15.17.1 What Hyperdoc does . . . . .	2621
15.18htxintropage2.ht . . . . .	2622
15.18.1 How Hyperdoc does it . . . . .	2622
15.19htxintropage3.ht . . . . .	2624
15.19.1 A simple text page . . . . .	2624
15.20htxintrotoppage.ht . . . . .	2626
15.20.1 First Steps . . . . .	2626
15.21htxlinkpage1.ht . . . . .	2627
15.21.1 Linking to a named page . . . . .	2627
15.21.2 HTXLinkPage1xPatch1 patch . . . . .	2629
15.21.3 HTXLinkPage1xPatch1A patch . . . . .	2629
15.21.4 Test Help Page . . . . .	2630
15.22htxlinkpage2.ht . . . . .	2630
15.22.1 Standard Pages . . . . .	2630
15.22.2 HTXLinkPage2xPatch1 patch . . . . .	2632
15.22.3 HTXLinkPage2xPatch1A patch . . . . .	2632
15.23htxlinkpage3.ht . . . . .	2633
15.23.1 Active Axiom commands . . . . .	2633
15.23.2 HTXLinkPage3xPatch1 patch . . . . .	2636
15.23.3 HTXLinkPage3xPatch1A patch . . . . .	2637
15.23.4 HTXLinkPage3xPatch2 patch . . . . .	2637
15.23.5 HTXLinkPage3xPatch2A patch . . . . .	2637
15.23.6 HTXLinkPage3xPatch3 patch . . . . .	2638
15.23.7 HTXLinkPage3xPatch3A patch . . . . .	2638
15.24htxlinkpage4.ht . . . . .	2639
15.24.1 Linking to Lisp . . . . .	2639
15.24.2 HTXLinkPage4xPatch1 patch . . . . .	2643
15.24.3 HTXLinkPage4xPatch1A patch . . . . .	2644
15.24.4 HTXLinkPage4xPatch2 patch . . . . .	2644
15.24.5 HTXLinkPage4xPatch2A patch . . . . .	2644
15.24.6 HTXLinkPage4xPatch3 patch . . . . .	2645
15.24.7 HTXLinkPage4xPatch3A patch . . . . .	2645
15.24.8 HTXLinkPage4xPatch4 patch . . . . .	2646
15.24.9 HTXLinkPage4xPatch4A patch . . . . .	2646
15.24.10 HTXLinkPage4xPatch5 patch . . . . .	2646



15.24.1HTXLinkPage4xPatch5A patch . . . . .	2647
15.25htxlinkpage5.ht . . . . .	2648
15.25.1 Linking to Unix . . . . .	2648
15.25.2HTXLinkPage5xPatch1 patch . . . . .	2649
15.25.3HTXLinkPage5xPatch1A patch . . . . .	2650
15.25.4HTXLinkPage5xPatch2 patch . . . . .	2650
15.25.5HTXLinkPage5xPatch2A patch . . . . .	2650
15.26htxlinkpage6.ht . . . . .	2651
15.26.1 How to use your pages with Hyperdoc . . . . .	2651
15.26.2HTXLinkPage6xPatch1 patch . . . . .	2653
15.26.3HTXLinkPage6xPatch1A patch . . . . .	2655
15.26.4HTXLinkPage6xPatch2 patch . . . . .	2655
15.26.5HTXLinkPage6xPatch2A patch . . . . .	2656
15.27htxlinktoppage.ht . . . . .	2656
15.27.1 Actions in Hyperdoc . . . . .	2656
15.28htxtoppage.ht . . . . .	2657
15.28.1 Extending Hyperdoc . . . . .	2657
15.29htxtrypage.ht . . . . .	2658
15.29.1 Try out Hyperdoc . . . . .	2658
<b>16 NAG Library Routines</b>	<b>2661</b>
16.1 nagaux.ht . . . . .	2661
16.1.1 NAG On-line Documentation . . . . .	2661
16.1.2 NAG Documentation: summary . . . . .	2663
16.1.3 NAG Documentation: introduction . . . . .	2685
16.1.4 NAG Documentation: keyword in context . . . . .	2702
16.1.5 NAG Documentation: conversion . . . . .	2800
16.2 nagc.ht . . . . .	2803
16.2.1 Zeros of Polynomials . . . . .	2803
16.2.2 Roots of a complex polynomial equation . . . . .	2807
16.2.3 Roots of a real polynomial equation . . . . .	2812
16.2.4 Roots of One or More Transcendental Equations . . . . .	2818
16.2.5 Zero of a continuous function in a given interval . . . . .	2822
16.2.6 Solution of a system of nonlinear equations . . . . .	2826
16.2.7 Solution of a system of nonlinear equations . . . . .	2830
16.2.8 Checks the gradients of a set of non-linear functions . . . . .	2836
16.2.9 Discrete Fourier transform of real or complex data values . . . . .	2839
16.2.10 Discrete Fourier transform of n real data values . . . . .	2847
16.2.11 Discrete Fourier transform of a Hermitian sequence . . . . .	2850
16.2.12 Discrete Fourier transform of n complex data values . . . . .	2854
16.2.13 Circular convolution or correlation of two real vectors . . . . .	2857
16.2.14 Discrete Fourier transforms of m sequences . . . . .	2861
16.2.15 Discrete Fourier transforms of m Hermitian sequences . . . . .	2866
16.2.16 Discrete Fourier transforms of m complex sequences . . . . .	2870
16.2.17 Discrete Fourier transform of bivariate complex data . . . . .	2874
16.2.18 Summation of Series . . . . .	2879

16.2.19	Complex conjugate of a sequence of $n$ data values . . . . .	2881
16.2.20	Complex conjugates of $m$ Hermitian sequences . . . . .	2883
16.2.21	Form real and imaginary parts of $m$ Hermitian sequences . . . . .	2885
16.3	nagd.ht . . . . .	2888
16.3.1	Quadrature . . . . .	2888
16.3.2	Approximation of the integral over a finite interval . . . . .	2901
16.3.3	Adaptive integration over a finite integral . . . . .	2907
16.3.4	Approximate integration with local singular points . . . . .	2913
16.3.5	Approximate integration over a (semi-)infinite interval . . . . .	2919
16.3.6	Approximate sine or cosine transform over finite interval . . . . .	2925
16.3.7	Adaptive integration of weighted function over an interval . . . . .	2931
16.3.8	Hilbert transform over finite interval . . . . .	2937
16.3.9	Approximate Sine or Cosine over $[a, \infty]$ . . . . .	2943
16.3.10	Weights and abscissae for Gaussian quadrature formula . . . . .	2950
16.3.11	Multidimensional integrals with finite limits . . . . .	2956
16.3.12	Third-order finite-difference integration . . . . .	2961
16.3.13	Monte Carlo integration over hyper-rectangular regions . . . . .	2964
16.3.14	Ordinary Differential Equations . . . . .	2969
16.3.15	First-order ODE over an interval with initial conditions . . . . .	2976
16.3.16	First-order ODE with initial conditions and user function . . . . .	2984
16.3.17	First-order ODE with variable-order, variable-step . . . . .	2992
16.3.18	Stiff First-order ODE with variable order and step . . . . .	3001
16.3.19	Two-point boundary-value ODE . . . . .	3010
16.3.20	Two-point boundary value ODE with deferred correction . . . . .	3017
16.3.21	Eigenvalue of regular singular 2nd-order Sturm-Liouville . . . . .	3025
16.3.22	Two-point boundary-value ODE equation systems . . . . .	3048
16.3.23	Partial differential equations . . . . .	3062
16.3.24	Discrete elliptic PDE on rectangular region . . . . .	3069
16.3.25	Discrete 2nd-order elliptic PDE on rectangular regions . . . . .	3077
16.3.26	Helmholtz equation in 3 dimensions . . . . .	3090
16.4	nage.ht . . . . .	3100
16.4.1	Interpolation . . . . .	3100
16.4.2	Cubic spline interpolant . . . . .	3105
16.4.3	Monotonicity-preserving piecewise cubic Hermite interpolant . . . . .	3110
16.4.4	Piecewise cubic Hermite interpolant . . . . .	3113
16.4.5	Piecewise cubic Hermite interpolant and 1st deriv . . . . .	3116
16.4.6	Definite integral of piecewise cubic Hermite interpolant . . . . .	3119
16.4.7	Bicubic spline interpolated surface . . . . .	3121
16.4.8	Two-D surface interpolating a set of scattered data points . . . . .	3128
16.4.9	Evaluate 2D interpolant function from E01SAF . . . . .	3131
16.4.10	Generate 2D surface interpolating a scattered data points . . . . .	3134
16.4.11	Evaluate 2D interpolating function from E01SEF . . . . .	3140
16.4.12	Curve and Surface Fitting . . . . .	3143
16.4.13	Least-squares polynomial approximations . . . . .	3168
16.4.14	Evaluate polynomial from Chebyshev-series representation . . . . .	3174
16.4.15	Constrained weighted least-squares polynomial . . . . .	3178

16.4.16	Coefficients of polynomial derivative . . . . .	3186
16.4.17	Find coefficients of indefinite integral of polynomial . . . . .	3191
16.4.18	Evaluate polynomial in Chebyshev-series representation . . . . .	3196
16.4.19	Weighted least-squares approx to data points . . . . .	3201
16.4.20	Evaluates a cubic spline from its B-spline representation . . . . .	3208
16.4.21	Evaluate cubic spline and 3 derivatives from B-spline . . . . .	3212
16.4.22	Definite integral of cubic spline from B-spline . . . . .	3217
16.4.23	Cubic spline approximation to an arbitrary set points . . . . .	3221
16.4.24	Minimal, weighted least-squares bicubic spline fit . . . . .	3230
16.4.25	Bicubic spline approximation to a set of data values . . . . .	3239
16.4.26	Bicubic spline approximation to a set of scattered data . . . . .	3250
16.4.27	Calculates values of a bicubic spline from B-spline . . . . .	3262
16.4.28	Calculates values of a bicubic spline from B-spline . . . . .	3266
16.4.29	Calculates $l_1$ solution to over-determined system equations . . . . .	3270
16.4.30	Sorts two-dimensional data into rectangular panels . . . . .	3276
16.4.31	Minimizing or Maximizing a Function . . . . .	3280
16.4.32	Minimizes a nonlinear function of several variable . . . . .	3305
16.4.33	Supply optional parameters to E04DGF from file . . . . .	3320
16.4.34	Supply individual optional params to E04DGF . . . . .	3323
16.4.35	Finding an unconstrained minimum of a sum of squares . . . . .	3325
16.4.36	Finding an unconstrained minimum of a sum of squares . . . . .	3331
16.4.37	Finding a minimum of a function . . . . .	3338
16.4.38	Solving linear programming problems . . . . .	3344
16.4.39	Solving linear or quadratic problems . . . . .	3353
16.4.40	Minimize an arbitrary smooth constrained function . . . . .	3373
16.4.41	Supply optional parameters to E04UCF from file . . . . .	3424
16.4.42	Supply individual optional params to E04UCF . . . . .	3427
16.4.43	Estimates of elements of the variance-covariance matrix . . . . .	3430
16.5	nagf.ht . . . . .	3436
16.5.1	Linear Algebra . . . . .	3436
16.5.2	Matrix Factorization . . . . .	3440
16.5.3	Factorizes a real sparse matrix . . . . .	3443
16.5.4	Factorizes a real sparse matrix . . . . .	3453
16.5.5	Incomplete Cholesky factorization . . . . .	3459
16.5.6	Cholesky factor of a symmetric positive-definite matrix . . . . .	3466
16.5.7	QR factorization of the real m by n matrix A . . . . .	3471
16.5.8	$B := QB$ or $B := Q^T B$ . . . . .	3476
16.5.9	First ncolq columns of the real m by m orthogonal matrix . . . . .	3481
16.5.10	QR factorization of the complex m by n matrix A . . . . .	3485
16.5.11	$B := QB$ or $B := Q^H B$ . . . . .	3490
16.5.12	First ncolq columns of the complex m by m unitary matrix . . . . .	3496
16.5.13	Eigenvalues and Eigenvectors . . . . .	3501
16.5.14	Calculates all the eigenvalues of a real symmetric matrix . . . . .	3507
16.5.15	Eigenvalues and eigenvectors of a real symmetric matrix . . . . .	3509
16.5.16	Calculates all the eigenvalues of $Ax = \lambda Bx$ . . . . .	3512
16.5.17	Eigenvalues and eigenvectors of $Ax = \lambda Bx$ . . . . .	3515

16.5.18	Calculates all the eigenvalues of a real unsymmetric matrix . . . . .	3519
16.5.19	Eigenvalues and eigenvectors of a real unsymmetric matrix . . . . .	3521
16.5.20	Calculates all the eigenvalues of a complex matrix . . . . .	3524
16.5.21	Eigenvalues and eigenvectors of a complex matrix . . . . .	3527
16.5.22	Eigenvalues of a complex Hermitian matrix . . . . .	3530
16.5.23	Eigenvalues/eigenvectors complex Hermitian matrix . . . . .	3533
16.5.24	Eigenvalues and eigenvectors of a real symmetric matrix . . . . .	3536
16.5.25	Eigenvalues of generalized eigenproblem $Ax = \lambda Bx$ . . . . .	3540
16.5.26	Eigenvalues and eigenvectors of real sparse symmetric problem . . . .	3545
16.5.27	Singular value decomposition of a general real matrix . . . . .	3558
16.5.28	Singular value decomposition of a general complex matrix . . . . .	3566
16.5.29	Simultaneous Linear Equations . . . . .	3573
16.5.30	Approximate solution of a set of complex linear equations . . . . .	3579
16.5.31	Approximate solution of a set of real linear equations . . . . .	3582
16.5.32	Real symmetric positive-definite linear equations . . . . .	3585
16.5.33	Set of real linear equations with a single right-hand side . . . . .	3589
16.5.34	Solution of a set of real sparse linear equations . . . . .	3592
16.5.35	Real symmetric positive-definite tridiagonal linear equations . . . . .	3595
16.5.36	Solution of a linear least-squares problem, $Ax = b$ . . . . .	3601
16.5.37	Sparse symmetric positive-definite system linear equations . . . . .	3607
16.5.38	Solves a system of real sparse symmetric linear equations . . . . .	3613
16.5.39	Solution of a system of real linear equations . . . . .	3624
16.5.40	Solves sparse unsymmetric equations . . . . .	3629
16.5.41	Linear Algebra Support Routines . . . . .	3643
16.5.42	Linear Equations (LAPACK) . . . . .	3676
16.5.43	Computes the LU factorization of a real m by n matrix . . . . .	3677
16.5.44	Solves a real system of linear equations . . . . .	3681
16.5.45	Factorization of a real symmetric positive-definite matrix . . . . .	3685
16.5.46	Real symmetric positive-definite system of linear equations . . . . .	3688
16.5.47	Sort vector of double precision numbers . . . . .	3695
16.5.48	Ranks a vector of double precision numbers . . . . .	3698
16.5.49	Ranks the rows of a matrix of double precision numbers . . . . .	3701
16.5.50	Ranks the columns of a matrix of double precision numbers . . . . .	3704
16.5.51	Rearranges a vector of double precision numbers . . . . .	3707
16.5.52	Inverts a permutation . . . . .	3709
16.6	nags.ht . . . . .	3712
16.6.1	Approximations of Special Functions . . . . .	3712
16.6.2	Exponential function $e^z$ , for complex $z$ . . . . .	3725
16.6.3	Returns the value of the exponential integral $E(x)$ . . . . .	3728
16.6.4	Returns the value of the cosine integral . . . . .	3731
16.6.5	Returns the value of the sine integral . . . . .	3734
16.6.6	Returns the value of the Gamma function . . . . .	3737
16.6.7	Returns a value for the logarithm of the Gamma function . . . . .	3740
16.6.8	Incomplete gamma functions $P(a,x)$ and $Q(a,x)$ . . . . .	3744
16.6.9	Returns the value of the complementary error function . . . . .	3747
16.6.10	Returns the value of the error function $\operatorname{erfx}$ . . . . .	3751

16.6.11	Returns the value of the Bessel Function $Y_0(x)$ . . . . .	3753
16.6.12	Returns the value of the Bessel Function $Y_1(x)$ . . . . .	3757
16.6.13	Returns the value of the Bessel Function $J_0(x)$ . . . . .	3762
16.6.14	Returns the value of the Bessel Function $J_1(x)$ . . . . .	3766
16.6.15	Returns a value for the Airy function, $Ai(x)$ . . . . .	3769
16.6.16	Returns a value of the Airy function, $Bi(x)$ . . . . .	3774
16.6.17	Value of the derivative of the Airy function $Ai(x)$ . . . . .	3778
16.6.18	Value for the derivative of the Airy function $Bi(x)$ . . . . .	3782
16.6.19	Values for the Bessel functions $Y_{\nu+n}(z)$ . . . . .	3786
16.6.20	Values for the Bessel functions $J_{\nu+n}(z)$ . . . . .	3791
16.6.21	Value of the Airy function $Ai(z)$ or derivative $Ai'(z)$ . . . . .	3796
16.6.22	Value of the Airy function $Bi(z)$ or derivative $Bi'(z)$ . . . . .	3800
16.6.23	Returns a sequence of values for the Hankel functions . . . . .	3804
16.6.24	Returns the value of the modified Bessel Function $K_0(x)$ . . . . .	3810
16.6.25	Returns the value of the modified Bessel Function $K_1(x)$ . . . . .	3813
16.6.26	Returns the value of the modified Bessel Function $I_0(x)$ . . . . .	3817
16.6.27	Returns a value for the modified Bessel Function $I_1(x)$ . . . . .	3821
16.6.28	Sequence of values for the modified Bessel $K_{\nu_n}(z)$ . . . . .	3824
16.6.29	Sequence of values for the modified Bessel $I_{\nu+n}$ . . . . .	3829
16.6.30	Returns a value for the Kelvin function ber x . . . . .	3833
16.6.31	Returns a value for the Kelvin function bei x . . . . .	3837
16.6.32	Returns a value for the Kelvin function ker x . . . . .	3840
16.6.33	Returns a value for the Kelvin function keix . . . . .	3844
16.6.34	Returns a value for the Fresnel Integral $S(x)$ . . . . .	3848
16.6.35	Returns a value for the Fresnel Integral $C(x)$ . . . . .	3852
16.6.36	Returns a value of an elementary integral . . . . .	3857
16.6.37	Value of the symmetrised elliptic integral of first kind . . . . .	3860
16.6.38	Value of the symmetrised elliptic integral of second kind . . . . .	3864
16.6.39	Value of the symmetrised elliptic integral of third kind . . . . .	3869
16.7	nagx.ht . . . . .	3874
16.7.1	Mathematical Constants . . . . .	3874
16.7.2	Machine Constants . . . . .	3875
16.7.3	Input/Output Utilities . . . . .	3882
16.7.4	Value of the current error message unit number . . . . .	3884
16.7.5	Value of the current advisory message unit number . . . . .	3887
16.7.6	Print a real matrix stored in a two-dimensional array . . . . .	3889
16.7.7	Print a complex matrix stored in a 2D array . . . . .	3892
16.7.8	Date and Time Utilities . . . . .	3896
16.7.9	Returns the current date and time . . . . .	3898
16.7.10	From seven-integer format time and date to character string . . . . .	3899
16.7.11	Compares two date/time character strings . . . . .	3902
16.7.12	Amount of processor time used . . . . .	3905

<b>17 NAG ASP Example Code</b>	<b>3907</b>
17.1 aspex.ht . . . . .	3907
17.1.1 Asp1 Example Code . . . . .	3907
17.1.2 Asp10 Example Code . . . . .	3907
17.1.3 Asp12 Example Code . . . . .	3908
17.1.4 Asp19 Example Code . . . . .	3908
17.1.5 Asp20 Example Code . . . . .	3911
17.1.6 Asp24 Example Code . . . . .	3911
17.1.7 Asp27 Example Code . . . . .	3912
17.1.8 Asp28 Example Code . . . . .	3912
17.1.9 Asp29 Example Code . . . . .	3915
17.1.10 Asp30 Example Code . . . . .	3916
17.1.11 Asp31 Example Code . . . . .	3917
17.1.12 Asp33 Example Code . . . . .	3917
17.1.13 Asp34 Example Code . . . . .	3918
17.1.14 Asp35 Example Code . . . . .	3918
17.1.15 Asp4 Example Code . . . . .	3919
17.1.16 Asp41 Example Code . . . . .	3919
17.1.17 Asp42 Example Code . . . . .	3920
17.1.18 Asp49 Example Code . . . . .	3921
17.1.19 Asp50 Example Code . . . . .	3922
17.1.20 Asp55 Example Code . . . . .	3923
17.1.21 Asp6 Example Code . . . . .	3924
17.1.22 Asp7 Example Code . . . . .	3924
17.1.23 Asp73 Example Code . . . . .	3925
17.1.24 Asp74 Example Code . . . . .	3925
17.1.25 Asp77 Example Code . . . . .	3926
17.1.26 Asp78 Example Code . . . . .	3927
17.1.27 Asp8 Example Code . . . . .	3927
17.1.28 Asp80 Example Code . . . . .	3928
17.1.29 Asp9 Example Code . . . . .	3928
<b>18 NAG ANNA Expert System</b>	<b>3931</b>
18.1 annaex.ht . . . . .	3931
18.1.1 Axiom/NAG Expert System . . . . .	3931
18.1.2 Integration . . . . .	3932
18.1.3 Ordinary Differential Equations . . . . .	3933
18.1.4 Optimization . . . . .	3933
18.1.5 Partial Differential Equations . . . . .	3934
18.1.6 Examples Using the Axiom/NAG Expert System . . . . .	3935
18.1.7 Examples Using the Axiom/NAG Expert System . . . . .	3936
18.1.8 Examples Using the Axiom/NAG Expert System . . . . .	3937
18.1.9 Examples Using the Axiom/NAG Expert System . . . . .	3939
18.1.10 About the Axiom/NAG Expert System . . . . .	3940
18.1.11 Introduction to the Axiom/NAG Expert System . . . . .	3941
18.1.12 Example using the Axiom/NAG Expert System . . . . .	3942

18.1.13 Example using the Axiom/NAG Expert System . . . . .	3947
18.1.14 Example using the Axiom/NAG Expert System . . . . .	3948
18.1.15 Decision Agents . . . . .	3949
18.1.16 Inference Mechanisms . . . . .	3950
18.1.17 Method Domains . . . . .	3951
18.1.18 Measure Functions . . . . .	3952
18.1.19 Computational Agents . . . . .	3953
<b>19 ANNA Algebra Code</b>	<b>3955</b>
<b>20 Page hierarchy layout</b>	<b>3957</b>
<b>21 Makefile</b>	<b>3991</b>

## Volume 8: Axiom Graphics

<b>1</b>	<b>Overview</b>	<b>1</b>
1.1	Standard Curves and Surfaces . . . . .	1
1.2	CRC graphs . . . . .	3
1.3	Environment Settings . . . . .	4
1.3.1	X11 .Xdefaults . . . . .	4
1.3.2	Shell Variables . . . . .	5
1.4	Pre-release change history . . . . .	5
<b>2</b>	<b>Graphics File Formats</b>	<b>11</b>
2.1	The viewFile data file format . . . . .	11
2.1.1	The viewType . . . . .	11
2.1.2	The title . . . . .	11
2.1.3	The window boundaries . . . . .	12
2.1.4	The graph specifications . . . . .	12
2.2	The graph file format . . . . .	14
2.2.1	The bounding values . . . . .	14
2.3	The parabola . . . . .	16
2.4	3D graph information . . . . .	20
<b>3</b>	<b>include</b>	<b>23</b>
3.1	actions.h . . . . .	23
3.2	colors.h . . . . .	27
3.3	component.h . . . . .	28
3.4	g.h . . . . .	30
3.5	nox10.h . . . . .	31
3.6	override.h . . . . .	32
3.7	rgb.h . . . . .	33
3.8	spadcolors.h . . . . .	34
3.9	tube.h . . . . .	34
3.10	view2d.h . . . . .	37
3.11	view3d.h . . . . .	39
3.12	viewcommand.h . . . . .	41
3.13	view.h . . . . .	42
3.14	write.h . . . . .	43
3.15	xdefs.h . . . . .	44
<b>4</b>	<b>viewman</b>	<b>45</b>
4.1	viewman Call Graph . . . . .	45
4.2	Constants and Headers . . . . .	47
4.2.1	defines . . . . .	47
4.2.2	System includes . . . . .	48
4.2.3	Local includes . . . . .	49
4.2.4	extern references . . . . .	49



4.2.5	forward references . . . . .	50
4.2.6	global variables . . . . .	50
4.3	Code . . . . .	51
4.3.1	endChild . . . . .	51
4.3.2	rmViewMgr . . . . .	52
4.3.3	closeChildViewport . . . . .	53
4.3.4	goodbye . . . . .	54
4.3.5	funView2D . . . . .	55
4.3.6	forkView2D . . . . .	58
4.3.7	sendGraphToView2D . . . . .	61
4.3.8	funView3D . . . . .	63
4.3.9	forkView3D . . . . .	67
4.3.10	makeView2DFromSpadData . . . . .	70
4.3.11	makeView3DFromSpadData . . . . .	71
4.3.12	makeGraphFromSpadData . . . . .	74
4.3.13	discardGraph . . . . .	75
4.3.14	readViewport . . . . .	75
4.3.15	superSelect . . . . .	76
4.3.16	brokenPipe . . . . .	76
4.3.17	main . . . . .	77
<b>5</b>	<b>viewalone</b>	<b>81</b>
5.1	viewalone Call Graph . . . . .	81
5.2	Constants and Headers . . . . .	82
5.2.1	System includes . . . . .	82
5.2.2	Local includes . . . . .	83
5.2.3	defines . . . . .	83
5.2.4	extern references . . . . .	84
5.2.5	global variables . . . . .	85
5.3	Code . . . . .	86
5.3.1	sendGraphToView2D . . . . .	86
5.3.2	makeView2DFromFileData . . . . .	88
5.3.3	makeView3DFromFileData . . . . .	92
5.3.4	spoonView2D . . . . .	95
5.3.5	spoonView3D . . . . .	97
5.3.6	main . . . . .	100
<b>6</b>	<b>view2d</b>	<b>101</b>
6.1	view2d Call Graph . . . . .	101
6.2	Constants and Headers . . . . .	110
6.2.1	System includes . . . . .	110
6.2.2	local includes . . . . .	111
6.2.3	static variables . . . . .	111
6.2.4	structs . . . . .	111
6.2.5	defines . . . . .	113
6.2.6	extern references . . . . .	119

6.2.7	forward references . . . . .	120
6.2.8	global variables . . . . .	122
6.3	Code . . . . .	125
6.3.1	initButtons . . . . .	125
6.3.2	writeControlTitle . . . . .	138
6.3.3	makeMessageFromData . . . . .	139
6.3.4	writeControlMessage . . . . .	140
6.3.5	drawControlPanel . . . . .	141
6.3.6	getControlXY . . . . .	145
6.3.7	makeControlPanel . . . . .	147
6.3.8	putControlPanelSomewhere . . . . .	149
6.3.9	clearControlMessage . . . . .	149
6.3.10	getGraphFromViewman . . . . .	150
6.3.11	freeGraph . . . . .	152
6.3.12	mergeDatabases . . . . .	153
6.3.13	getPotValue . . . . .	154
6.3.14	doPick . . . . .	154
6.3.15	doDrop . . . . .	155
6.3.16	clickedOnGraphSelect . . . . .	156
6.3.17	drawControlPushButton . . . . .	157
6.3.18	buttonAction . . . . .	158
6.3.19	processEvents . . . . .	164
6.3.20	clickedOnGraph . . . . .	171
6.3.21	readViewman . . . . .	172
6.3.22	spadAction . . . . .	173
6.3.23	absolute . . . . .	177
6.3.24	goodbye . . . . .	178
6.3.25	writeTitle . . . . .	179
6.3.26	drawTheViewport . . . . .	180
6.3.27	makeViewport . . . . .	189
6.3.28	makeView2D . . . . .	191
6.3.29	writeViewport . . . . .	192
6.3.30	main . . . . .	196
<b>7</b>	<b>view3d</b>	<b>203</b>
7.1	view3d Call Graph . . . . .	203
7.2	Constants and Headers . . . . .	216
7.2.1	System includes . . . . .	216
7.2.2	Local includes . . . . .	216
7.2.3	defines . . . . .	217
7.2.4	static variables . . . . .	232
7.2.5	structs . . . . .	233
7.2.6	extern references . . . . .	236
7.2.7	forward references . . . . .	239
7.2.8	global variables . . . . .	243
7.3	Code . . . . .	249

7.3.1	initButtons . . . . .	249
7.3.2	closeViewport . . . . .	256
7.3.3	scaleComponents . . . . .	257
7.3.4	makeTriangle . . . . .	259
7.3.5	triangulate . . . . .	260
7.3.6	readComponentsFromViewman . . . . .	263
7.3.7	calcNormData . . . . .	265
7.3.8	make3DComponents . . . . .	267
7.3.9	draw3DComponents . . . . .	268
7.3.10	drawColorMap . . . . .	277
7.3.11	writeControlTitle . . . . .	278
7.3.12	clearControlMessage . . . . .	279
7.3.13	writeControlMessage . . . . .	279
7.3.14	drawControlPanel . . . . .	280
7.3.15	getControlXY . . . . .	292
7.3.16	makeControlPanel . . . . .	294
7.3.17	putControlPanelSomewhere . . . . .	296
7.3.18	phong . . . . .	297
7.3.19	hueValue . . . . .	298
7.3.20	getHue . . . . .	298
7.3.21	Value . . . . .	299
7.3.22	hlsTOrgb . . . . .	299
7.3.23	initLightButtons . . . . .	300
7.3.24	makeLightingPanel . . . . .	302
7.3.25	drawLightingAxes . . . . .	304
7.3.26	drawLightTransArrow . . . . .	306
7.3.27	drawLightingPanel . . . . .	308
7.3.28	theHandler . . . . .	312
7.3.29	mergeDatabases . . . . .	313
7.3.30	getMeshNormal . . . . .	314
7.3.31	normalizeVector . . . . .	314
7.3.32	dotProduct . . . . .	315
7.3.33	merge . . . . .	316
7.3.34	msort . . . . .	317
7.3.35	getPotValue . . . . .	318
7.3.36	getLinearPotValue . . . . .	318
7.3.37	buttonAction . . . . .	319
7.3.38	processEvents . . . . .	335
7.3.39	project . . . . .	351
7.3.40	projectAPoint . . . . .	352
7.3.41	projectAllPoints . . . . .	353
7.3.42	projectAllPolys . . . . .	354
7.3.43	projectAPoly . . . . .	356
7.3.44	projectStuff . . . . .	358
7.3.45	makeQuitPanel . . . . .	359
7.3.46	drawQuitPanel . . . . .	361

7.3.47	initQuitButtons . . . . .	362
7.3.48	makeSavePanel . . . . .	363
7.3.49	drawSavePanel . . . . .	364
7.3.50	initSaveButtons . . . . .	365
7.3.51	getCBufferAxes . . . . .	366
7.3.52	putCBufferAxes . . . . .	366
7.3.53	getCBufferIndx . . . . .	366
7.3.54	putCBufferIndx . . . . .	366
7.3.55	putZBuffer . . . . .	367
7.3.56	getZBuffer . . . . .	367
7.3.57	putImageX . . . . .	367
7.3.58	drawPhongSpan . . . . .	368
7.3.59	scanPhong . . . . .	370
7.3.60	boxTObuffer . . . . .	373
7.3.61	clipboxTObuffer . . . . .	375
7.3.62	axesTObuffer . . . . .	377
7.3.63	scanLines . . . . .	379
7.3.64	freePolyList . . . . .	382
7.3.65	showAxesLabels . . . . .	383
7.3.66	makeTriangle . . . . .	385
7.3.67	drawPhong . . . . .	387
7.3.68	readViewman . . . . .	390
7.3.69	scalePoint . . . . .	390
7.3.70	spadAction . . . . .	391
7.3.71	traverse . . . . .	397
7.3.72	absolute . . . . .	397
7.3.73	getRandom . . . . .	397
7.3.74	normDist . . . . .	398
7.3.75	goodbye . . . . .	398
7.3.76	drawLineComponent . . . . .	399
7.3.77	drawOpaquePolygon . . . . .	400
7.3.78	copyPolygons . . . . .	402
7.3.79	minMaxPolygons . . . . .	404
7.3.80	polyCompare . . . . .	405
7.3.81	makeTriangle . . . . .	405
7.3.82	makeTriangle . . . . .	406
7.3.83	freePointReservoir . . . . .	409
7.3.84	freeListOfPolygons . . . . .	409
7.3.85	drawPolygons . . . . .	410
7.3.86	lessThan . . . . .	413
7.3.87	greaterThan . . . . .	413
7.3.88	isNaN . . . . .	413
7.3.89	isNaNPoint . . . . .	413
7.3.90	equal . . . . .	414
7.3.91	matrixMultiply4x4 . . . . .	415
7.3.92	vectorMatrix4 . . . . .	416

7.3.93	ROTATE . . . . .	416
7.3.94	ROTATE1 . . . . .	417
7.3.95	SCALE . . . . .	417
7.3.96	TRANSLATE . . . . .	417
7.3.97	writeTitle . . . . .	418
7.3.98	drawPreViewport . . . . .	419
7.3.99	drawTheViewport . . . . .	425
7.3.100	makeViewport . . . . .	427
7.3.101	postMakeViewport . . . . .	432
7.3.102	keepDrawingViewport . . . . .	434
7.3.103	initVolumeButtons . . . . .	435
7.3.104	makeVolumePanel . . . . .	438
7.3.105	drawClipXBut . . . . .	440
7.3.106	drawClipYBut . . . . .	442
7.3.107	drawClipZBut . . . . .	444
7.3.108	drawClipVolume . . . . .	445
7.3.109	drawHitherControl . . . . .	447
7.3.110	drawEyeControl . . . . .	448
7.3.111	drawFrustrum . . . . .	449
7.3.112	drawVolumePanel . . . . .	450
7.3.113	writeViewport . . . . .	453
7.3.114	main . . . . .	457
<b>8</b>	<b>gdraws</b>	<b>465</b>
8.0.115	Gdraw . . . . .	465
8.0.116	To use G Functions . . . . .	466
8.1	gfun.c . . . . .	468
8.1.1	filecopy . . . . .	469
8.1.2	PSCreateFile . . . . .	470
8.1.3	GdrawsDrawFrame . . . . .	471
8.1.4	GdrawsSetDimension . . . . .	472
8.1.5	GDrawImageString . . . . .	473
8.1.6	GDrawArc . . . . .	474
8.1.7	GDrawLine . . . . .	475
8.1.8	GDrawLines . . . . .	476
8.1.9	GDrawPoint . . . . .	477
8.1.10	GDrawRectangle . . . . .	478
8.1.11	GDraw3DButtonIn . . . . .	479
8.1.12	GDraw3DButtonIn . . . . .	479
8.1.13	GDrawPushButton . . . . .	480
8.1.14	GDrawString . . . . .	481
8.1.15	GFillArc . . . . .	482
8.1.16	PSGlobalInit . . . . .	483
8.1.17	PSInit . . . . .	485
8.1.18	PSCreateContext . . . . .	486
8.1.19	PSfindGC . . . . .	487

8.1.20	GSetForeground . . . . .	488
8.1.21	GSetBackground . . . . .	489
8.1.22	GSetLineAttributes . . . . .	490
8.1.23	PSClose . . . . .	491
8.1.24	centerX . . . . .	492
8.1.25	centerY . . . . .	492
8.1.26	PSColorPolygon . . . . .	493
8.1.27	PSColorwOutline . . . . .	494
8.1.28	PSDrawColor . . . . .	495
8.1.29	PSFillPolygon . . . . .	496
8.1.30	PSFillwOutline . . . . .	497
8.1.31	TrivEqual . . . . .	497
8.1.32	TrivHashCode . . . . .	498
8.1.33	XCreateAssocTable . . . . .	498
8.1.34	XMakeAssoc . . . . .	498
8.1.35	XLookupAssoc . . . . .	498
8.1.36	XDeleteAssoc . . . . .	499
8.2	The postscript command definitions . . . . .	499
8.2.1	colorpoly . . . . .	499
8.2.2	colorwol . . . . .	500
8.2.3	drawarc . . . . .	501
8.2.4	drawcolor . . . . .	502
8.2.5	drawIstr . . . . .	503
8.2.6	drawline . . . . .	504
8.2.7	drawlines . . . . .	505
8.2.8	drawpoint . . . . .	505
8.2.9	draw . . . . .	506
8.2.10	drawrect . . . . .	506
8.2.11	drawstr . . . . .	507
8.2.12	drwfilled . . . . .	507
8.2.13	end . . . . .	508
8.2.14	fillarc . . . . .	509
8.2.15	fillpoly . . . . .	510
8.2.16	fillwol . . . . .	511
8.2.17	header . . . . .	512
8.2.18	setup . . . . .	515
<b>9</b>	<b>The APIs</b>	<b>517</b>
9.1	Graphics API . . . . .	517
9.1.1	XDrawString . . . . .	517
9.1.2	XDrawPoint . . . . .	518
9.1.3	XDrawLine . . . . .	518
9.1.4	XDrawImageString . . . . .	519
9.1.5	XFillArc . . . . .	520
9.1.6	XDrawArc . . . . .	521
9.1.7	XSetForeground . . . . .	522

<i>CONTENTS</i>	119
9.1.8 XSetBackground . . . . .	522
9.1.9 XSetLineAttributes . . . . .	522
9.1.10 DefaultScreen . . . . .	523
9.1.11 RootWindow . . . . .	523
9.1.12 XCreateAssocTable . . . . .	523
9.1.13 XOpenDisplay . . . . .	523
9.2 X11 API calls . . . . .	524
<b>10 Makefile</b>	<b>531</b>

## Volume 9: Axiom Compiler

0.1	Makefile . . . . .	1
<b>1</b>	<b>Overview</b>	<b>3</b>
1.1	The Input . . . . .	4
1.2	The Output, the EQ.nrlib directory . . . . .	8
1.3	The code.lsp and EQ.lsp files . . . . .	9
1.4	The code.o file . . . . .	23
1.5	The info file . . . . .	23
1.6	The EQ.fn file . . . . .	26
1.7	The index.kaf file . . . . .	31
1.7.1	The index offset byte . . . . .	33
1.7.2	The “loadTimeStuff” . . . . .	33
1.7.3	The “compilerInfo” . . . . .	35
1.7.4	The “constructorForm” . . . . .	42
1.7.5	The “constructorKind” . . . . .	42
1.7.6	The “constructorModemap” . . . . .	42
1.7.7	The “constructorCategory” . . . . .	44
1.7.8	The “sourceFile” . . . . .	45
1.7.9	The “modemaps” . . . . .	45
1.7.10	The “operationAlist” . . . . .	47
1.7.11	The “superDomain” . . . . .	49
1.7.12	The “signaturesAndLocals” . . . . .	49
1.7.13	The “attributes” . . . . .	49
1.7.14	The “predicates” . . . . .	49
1.7.15	The “abbreviation” . . . . .	50
1.7.16	The “parents” . . . . .	50
1.7.17	The “ancestors” . . . . .	51
1.7.18	The “documentation” . . . . .	51
1.7.19	The “slotInfo” . . . . .	53
1.7.20	The “index” . . . . .	55
<b>2</b>	<b>Compiler top level</b>	<b>57</b>
2.1	Global Data Structures . . . . .	57
2.2	Pratt Parsing . . . . .	57
2.3	)compile . . . . .	58
2.3.1	Spad compiler . . . . .	61
2.4	Operator Precedence Table Initialization . . . . .	62
2.4.1	LED and NUD Tables . . . . .	62
2.5	Gliph Table . . . . .	65
2.5.1	Rename Token Table . . . . .	65
2.5.2	Generic function table . . . . .	66
2.6	Giant steps, Baby steps . . . . .	66



<b>3</b>	<b>The Parser</b>	<b>67</b>
3.1	EQ.spad . . . . .	67
3.2	boot transformations . . . . .	71
3.2.1	defun string2BootTree . . . . .	71
3.2.2	defun new2OldLisp . . . . .	72
3.2.3	defun new2OldTran . . . . .	72
3.2.4	defun newIf2Cond . . . . .	73
3.2.5	defun newDef2Def . . . . .	74
3.2.6	defun new2OldDefForm . . . . .	74
3.2.7	defun newConstruct . . . . .	74
3.3	preparse . . . . .	75
3.3.1	defvar \$index . . . . .	75
3.3.2	defvar \$linelist . . . . .	75
3.3.3	defvar \$echolinestack . . . . .	75
3.3.4	defvar \$preparse-last-line . . . . .	76
3.4	Parsing routines . . . . .	76
3.4.1	defun initialize-preparse . . . . .	76
3.4.2	defun preparse . . . . .	80
3.4.3	defun Build the lines from the input for piles . . . . .	84
3.4.4	defun parsepiles . . . . .	87
3.4.5	defun add-parens-and-semis-to-line . . . . .	88
3.4.6	defun preparseReadLine . . . . .	89
3.4.7	defun skip-ifblock . . . . .	89
3.4.8	defun preparseReadLine1 . . . . .	90
3.4.9	defun expand-tabs . . . . .	91
3.5	I/O Handling . . . . .	92
3.5.1	defun preparse-echo . . . . .	92
3.5.2	Parsing stack . . . . .	92
3.5.3	defstruct \$stack . . . . .	92
3.5.4	defun stack-load . . . . .	92
3.5.5	defun stack-clear . . . . .	93
3.5.6	defmacro stack-/empty . . . . .	93
3.5.7	defun stack-push . . . . .	93
3.5.8	defun stack-pop . . . . .	94
3.5.9	Parsing token . . . . .	94
3.5.10	defstruct \$token . . . . .	94
3.5.11	defvar \$prior-token . . . . .	94
3.5.12	defvar \$nonblank . . . . .	95
3.5.13	defvar \$current-token . . . . .	95
3.5.14	defvar \$next-token . . . . .	95
3.5.15	defvar \$valid-tokens . . . . .	95
3.5.16	defun token-install . . . . .	96
3.5.17	defun token-print . . . . .	96
3.5.18	Parsing reduction . . . . .	96
3.5.19	defstruct \$reduction . . . . .	96

<b>4</b>	<b>Parse Transformers</b>	<b>97</b>
4.1	Direct called parse routines . . . . .	97
4.1.1	defun parseTransform . . . . .	97
4.1.2	defun parseTran . . . . .	97
4.1.3	defun parseAtom . . . . .	98
4.1.4	defun parseTranList . . . . .	99
4.1.5	defplist parseConstruct . . . . .	99
4.1.6	defun parseConstruct . . . . .	99
4.2	Indirect called parse routines . . . . .	100
4.2.1	defplist parseAnd . . . . .	101
4.2.2	defun parseAnd . . . . .	101
4.2.3	defplist parseAtSign . . . . .	101
4.2.4	defun parseAtSign . . . . .	102
4.2.5	defun parseType . . . . .	102
4.2.6	defplist parseCategory . . . . .	102
4.2.7	defun parseCategory . . . . .	103
4.2.8	defun parseDropAssertions . . . . .	103
4.2.9	defplist parseCoerce . . . . .	103
4.2.10	defun parseCoerce . . . . .	104
4.2.11	defplist parseColon . . . . .	104
4.2.12	defun parseColon . . . . .	104
4.2.13	defplist parseDEF . . . . .	105
4.2.14	defun parseDEF . . . . .	105
4.2.15	defun parseLhs . . . . .	106
4.2.16	defun transIs . . . . .	106
4.2.17	defun transIs1 . . . . .	106
4.2.18	defun isListConstructor . . . . .	107
4.2.19	defplist parseDollarGreaterthan . . . . .	107
4.2.20	defun parseDollarGreaterThan . . . . .	108
4.2.21	defplist parseDollarGreaterEqual . . . . .	108
4.2.22	defun parseDollarGreaterEqual . . . . .	108
4.2.23	defun parseDollarLessEqual . . . . .	109
4.2.24	defplist parseDollarNotEqual . . . . .	109
4.2.25	defun parseDollarNotEqual . . . . .	109
4.2.26	defplist parseEquivalence . . . . .	110
4.2.27	defun parseEquivalence . . . . .	110
4.2.28	defplist parseExit . . . . .	110
4.2.29	defun parseExit . . . . .	110
4.2.30	defplist parseGreaterEqual . . . . .	111
4.2.31	defun parseGreaterEqual . . . . .	111
4.2.32	defplist parseGreaterThan . . . . .	111
4.2.33	defun parseGreaterThan . . . . .	112
4.2.34	defplist parseHas . . . . .	112
4.2.35	defun parseHas . . . . .	112
4.2.36	defun parseHasRhs . . . . .	114
4.2.37	defun loadIfNecessary . . . . .	114

4.2.38	defun loadLibIfNecessary . . . . .	115
4.2.39	defun updateCategoryFrameForConstructor . . . . .	116
4.2.40	defun convertOpAlist2compilerInfo . . . . .	116
4.2.41	defun updateCategoryFrameForCategory . . . . .	117
4.2.42	defplist parseIf . . . . .	117
4.2.43	defun parseIf . . . . .	118
4.2.44	defun parseIf,ifTran . . . . .	118
4.2.45	defplist parseImplies . . . . .	120
4.2.46	defun parseImplies . . . . .	120
4.2.47	defplist parseIn . . . . .	121
4.2.48	defun parseIn . . . . .	121
4.2.49	defplist parseInBy . . . . .	122
4.2.50	defun parseInBy . . . . .	122
4.2.51	defplist parseIs . . . . .	123
4.2.52	defun parseIs . . . . .	123
4.2.53	defplist parseIsnt . . . . .	123
4.2.54	defun parseIsnt . . . . .	123
4.2.55	defplist parseJoin . . . . .	124
4.2.56	defun parseJoin . . . . .	124
4.2.57	defplist parseLeave . . . . .	124
4.2.58	defun parseLeave . . . . .	125
4.2.59	defplist parseLessEqual . . . . .	125
4.2.60	defun parseLessEqual . . . . .	125
4.2.61	defplist parseLET . . . . .	126
4.2.62	defun parseLET . . . . .	126
4.2.63	defplist parseLETD . . . . .	126
4.2.64	defun parseLETD . . . . .	127
4.2.65	defplist parseMDEF . . . . .	127
4.2.66	defun parseMDEF . . . . .	127
4.2.67	defplist parseNot . . . . .	128
4.2.68	defplist parseNot . . . . .	128
4.2.69	defun parseNot . . . . .	128
4.2.70	defplist parseNotEqual . . . . .	129
4.2.71	defun parseNotEqual . . . . .	129
4.2.72	defplist parseOr . . . . .	129
4.2.73	defun parseOr . . . . .	129
4.2.74	defplist parsePretend . . . . .	130
4.2.75	defun parsePretend . . . . .	130
4.2.76	defplist parseReturn . . . . .	131
4.2.77	defun parseReturn . . . . .	131
4.2.78	defplist parseSegment . . . . .	131
4.2.79	defun parseSegment . . . . .	131
4.2.80	defplist parseSeq . . . . .	132
4.2.81	defun parseSeq . . . . .	132
4.2.82	defplist parseVCONS . . . . .	132
4.2.83	defun parseVCONS . . . . .	133

4.2.84	defplist parseWhere . . . . .	133
4.2.85	defun parseWhere . . . . .	133
<b>5</b>	<b>Compile Transformers</b>	<b>135</b>
5.0.86	defun compExpression . . . . .	135
5.1	Handline Category DEF forms . . . . .	138
5.1.1	defplist compDefine plist . . . . .	140
5.1.2	defun compDefine . . . . .	140
5.1.3	defun compDefine1 . . . . .	141
5.1.4	defun compDefineAddSignature . . . . .	143
5.1.5	defun compDefineFunctor . . . . .	144
5.1.6	defun compDefineFunctor1 . . . . .	144
5.1.7	defun compDefineCapsuleFunction . . . . .	151
5.1.8	defun compInternalFunction . . . . .	155
5.1.9	defun compDefWhereClause . . . . .	155
5.1.10	defun compDefineCategory . . . . .	158
5.1.11	defun compDefineCategory1 . . . . .	158
5.1.12	defun compDefineCategory2 . . . . .	159
5.1.13	defun compDefineLisplib . . . . .	163
5.1.14	defun compileDocumentation . . . . .	165
5.1.15	defun compArgumentConditions . . . . .	166
5.1.16	defun compileCases . . . . .	167
5.1.17	defun compFunctorBody . . . . .	168
5.1.18	defun compile . . . . .	169
5.1.19	defvar \$NoValueMode . . . . .	172
5.1.20	defvar \$EmptyMode . . . . .	172
5.1.21	defun hasFullSignature . . . . .	172
5.1.22	defun addEmptyCapsuleIfNecessary . . . . .	173
5.1.23	defun getTargetFromRhs . . . . .	173
5.1.24	defun giveFormalParametersValues . . . . .	174
5.1.25	defun macroExpandInPlace . . . . .	174
5.1.26	defun macroExpand . . . . .	174
5.1.27	defun macroExpandList . . . . .	175
5.1.28	defun makeCategoryPredicates . . . . .	175
5.1.29	defun mkCategoryPackage . . . . .	176
5.1.30	defun mkEvalableCategoryForm . . . . .	178
5.1.31	defun encodeFunctionName . . . . .	179
5.1.32	defun mkRepetitionAssoc . . . . .	180
5.1.33	defun splitEncodedFunctionName . . . . .	180
5.1.34	defun encodeItem . . . . .	181
5.1.35	defun getCaps . . . . .	181
5.1.36	defun constructMacro . . . . .	182
5.1.37	defun spadCompileOrSetq . . . . .	182
5.1.38	defun compileConstructor . . . . .	183
5.1.39	defun compileConstructor1 . . . . .	184
5.1.40	defun compAndDefine . . . . .	185

5.1.41	defun putInLocalDomainReferences . . . . .	185
5.1.42	defun NRTputInTail . . . . .	185
5.1.43	defun NRTputInHead . . . . .	186
5.1.44	defun getArgumentModeOrMoan . . . . .	187
5.1.45	defun augLisplibModemapsFromCategory . . . . .	187
5.1.46	defun mkAlistOfExplicitCategoryOps . . . . .	189
5.1.47	defun flattenSignatureList . . . . .	190
5.1.48	defun interactiveModemapForm . . . . .	191
5.1.49	defun replaceVars . . . . .	192
5.1.50	defun fixUpPredicate . . . . .	192
5.1.51	defun orderPredicateItems . . . . .	193
5.1.52	defun signatureTran . . . . .	193
5.1.53	defun orderPredTran . . . . .	194
5.1.54	defun isDomainSubst . . . . .	196
5.1.55	defun moveORsOutside . . . . .	197
5.1.56	defun substVars . . . . .	198
5.1.57	defun modemapPattern . . . . .	199
5.1.58	defun evalAndRwriteLispForm . . . . .	200
5.1.59	defun rwriteLispForm . . . . .	200
5.1.60	defun mkConstructor . . . . .	201
5.1.61	defun unloadOneConstructor . . . . .	201
5.1.62	defun lisplibDoRename . . . . .	201
5.1.63	defun initializeLisplib . . . . .	202
5.1.64	defun writeLib1 . . . . .	203
5.1.65	defun finalizeLisplib . . . . .	203
5.1.66	defun getConstructorOpsAndAtts . . . . .	205
5.1.67	defun getCategoryOpsAndAtts . . . . .	205
5.1.68	defun getSlotFromCategoryForm . . . . .	206
5.1.69	defun transformOperationAlist . . . . .	206
5.1.70	defun getFunctorOpsAndAtts . . . . .	208
5.1.71	defun getSlotFromFunctor . . . . .	208
5.1.72	defun compMakeCategoryObject . . . . .	208
5.1.73	defun mergeSignatureAndLocalVarAlists . . . . .	209
5.1.74	defun lisplibWrite . . . . .	209
5.1.75	defun isCategoryPackageName . . . . .	210
5.1.76	defun NRTgetLookupFunction . . . . .	210
5.1.77	defun NRTgetLocalIndex . . . . .	211
5.1.78	defun augmentLisplibModemapsFromFunctor . . . . .	212
5.1.79	defun allLASSOCs . . . . .	213
5.1.80	defun formal2Pattern . . . . .	214
5.1.81	defun mkDatabasePred . . . . .	214
5.1.82	defun disallowNilAttribute . . . . .	214
5.1.83	defun bootStrapError . . . . .	215
5.1.84	defun reportOnFunctorCompilation . . . . .	215
5.1.85	defun displayMissingFunctions . . . . .	216
5.1.86	defun makeFunctorArgumentParameters . . . . .	217

5.1.87	defun genDomainViewList0 . . . . .	219
5.1.88	defun genDomainViewList . . . . .	219
5.1.89	defun genDomainView . . . . .	219
5.1.90	defun genDomainOps . . . . .	220
5.1.91	defun mkOpVec . . . . .	221
5.1.92	defun AssocBarGensym . . . . .	222
5.1.93	defun orderByDependency . . . . .	222
5.2	Code optimization routines . . . . .	223
5.2.1	defun optimizeFunctionDef . . . . .	223
5.2.2	defun optimize . . . . .	225
5.2.3	defun optXLAMCond . . . . .	226
5.2.4	defun optCONDtail . . . . .	226
5.2.5	defvar \$BasicPredicates . . . . .	227
5.2.6	defun optPredicateIfTrue . . . . .	227
5.2.7	defun optIF2COND . . . . .	227
5.2.8	defun subrname . . . . .	228
5.2.9	Special case optimizers . . . . .	228
5.2.10	defplist optCall . . . . .	229
5.2.11	defun Optimize “call” expressions . . . . .	229
5.2.12	defun optPackageCall . . . . .	230
5.2.13	defun optCallSpecially . . . . .	231
5.2.14	defun optSpecialCall . . . . .	232
5.2.15	defun compileTimeBindingOf . . . . .	233
5.2.16	defun optCallEval . . . . .	233
5.2.17	defplist optSEQ . . . . .	234
5.2.18	defun optSEQ . . . . .	234
5.2.19	defplist optEQ . . . . .	235
5.2.20	defun optEQ . . . . .	236
5.2.21	defplist optMINUS . . . . .	236
5.2.22	defun optMINUS . . . . .	236
5.2.23	defplist optQSMINUS . . . . .	237
5.2.24	defun optQSMINUS . . . . .	237
5.2.25	defplist opt- . . . . .	237
5.2.26	defun opt- . . . . .	238
5.2.27	defplist optLESSP . . . . .	238
5.2.28	defun optLESSP . . . . .	238
5.2.29	defplist optSPADCALL . . . . .	239
5.2.30	defun optSPADCALL . . . . .	239
5.2.31	defplist optSuchthat . . . . .	240
5.2.32	defun optSuchthat . . . . .	240
5.2.33	defplist optCatch . . . . .	240
5.2.34	defun optCatch . . . . .	240
5.2.35	defplist optCond . . . . .	242
5.2.36	defun optCond . . . . .	242
5.2.37	defun EqualBarGensym . . . . .	244
5.2.38	defplist optMkRecord . . . . .	245

5.2.39	defun optMkRecord . . . . .	245
5.2.40	defplist optRECORDELT . . . . .	245
5.2.41	defun optRECORDELT . . . . .	245
5.2.42	defplist optSETRECORDELT . . . . .	246
5.2.43	defun optSETRECORDELT . . . . .	246
5.2.44	defplist optRECORDCOPY . . . . .	247
5.2.45	defun optRECORDCOPY . . . . .	247
5.3	Functions to manipulate modemaps . . . . .	248
5.3.1	defun addDomain . . . . .	248
5.3.2	defun unknownTypeError . . . . .	249
5.3.3	defun isFunctor . . . . .	249
5.3.4	defun getDomainsInScope . . . . .	250
5.3.5	defun putDomainsInScope . . . . .	250
5.3.6	defun isSuperDomain . . . . .	251
5.3.7	defun addNewDomain . . . . .	251
5.3.8	defun augModemapsFromDomain . . . . .	252
5.3.9	defun augModemapsFromDomain1 . . . . .	252
5.3.10	defun substituteCategoryArguments . . . . .	253
5.3.11	defun addConstructorModemaps . . . . .	254
5.3.12	defun getModemap . . . . .	254
5.3.13	defun compApplyModemap . . . . .	255
5.3.14	defun compMapCond . . . . .	256
5.3.15	defun compMapCond' . . . . .	257
5.3.16	defun compMapCond" . . . . .	257
5.3.17	defun compMapCondFun . . . . .	258
5.3.18	defun getUniqueSignature . . . . .	259
5.3.19	defun getUniqueModemap . . . . .	259
5.3.20	defun getModemapList . . . . .	259
5.3.21	defun getModemapListFromDomain . . . . .	260
5.3.22	defun domainMember . . . . .	260
5.3.23	defun augModemapsFromCategory . . . . .	260
5.3.24	defun addEltModemap . . . . .	261
5.3.25	defun mkNewModemapList . . . . .	262
5.3.26	defun insertModemap . . . . .	263
5.3.27	defun mergeModemap . . . . .	263
5.3.28	defun TruthP . . . . .	264
5.3.29	defun evalAndSub . . . . .	265
5.3.30	defun getOperationAlist . . . . .	265
5.3.31	defvar \$FormalMapVariableList . . . . .	266
5.3.32	defun substNames . . . . .	266
5.3.33	defun augModemapsFromCategoryRep . . . . .	267
5.4	Maintaining Modemaps . . . . .	268
5.4.1	defun addModemapKnown . . . . .	268
5.4.2	defun addModemap . . . . .	269
5.4.3	defun addModemap0 . . . . .	269
5.4.4	defun addModemap1 . . . . .	270

5.5	Indirect called comp routines . . . . .	270
5.5.1	defplist compAdd plist . . . . .	271
5.5.2	defun compAdd . . . . .	271
5.5.3	defun compTuple2Record . . . . .	273
5.5.4	defplist compCapsule plist . . . . .	273
5.5.5	defun compCapsule . . . . .	274
5.5.6	defun compCapsuleInner . . . . .	274
5.5.7	defun processFunctor . . . . .	275
5.5.8	defun compCapsuleItems . . . . .	275
5.5.9	defun compSingleCapsuleItem . . . . .	276
5.5.10	defun doIt . . . . .	276
5.5.11	defun doItIf . . . . .	281
5.5.12	defun isMacro . . . . .	282
5.5.13	defplist compCase plist . . . . .	283
5.5.14	defun compCase . . . . .	283
5.5.15	defun compCase1 . . . . .	284
5.5.16	defplist compCat plist . . . . .	284
5.5.17	defplist compCat plist . . . . .	285
5.5.18	defplist compCat plist . . . . .	285
5.5.19	defun compCat . . . . .	285
5.5.20	defplist compCategory plist . . . . .	286
5.5.21	defun compCategory . . . . .	286
5.5.22	defun compCategoryItem . . . . .	287
5.5.23	defun mkExplicitCategoryFunction . . . . .	288
5.5.24	defun mustInstantiate . . . . .	289
5.5.25	defun wrapDomainSub . . . . .	290
5.5.26	defplist compColon plist . . . . .	290
5.5.27	defun compColon . . . . .	290
5.5.28	defun makeCategoryForm . . . . .	293
5.5.29	defplist compCons plist . . . . .	294
5.5.30	defun compCons . . . . .	294
5.5.31	defun compCons1 . . . . .	294
5.5.32	defplist compConstruct plist . . . . .	295
5.5.33	defun compConstruct . . . . .	295
5.5.34	defplist compConstructorCategory plist . . . . .	296
5.5.35	defplist compConstructorCategory plist . . . . .	296
5.5.36	defplist compConstructorCategory plist . . . . .	297
5.5.37	defplist compConstructorCategory plist . . . . .	297
5.5.38	defun compConstructorCategory . . . . .	297
5.5.39	defun getAbbreviation . . . . .	298
5.5.40	defun mkAbbrev . . . . .	298
5.5.41	defun addSuffix . . . . .	299
5.5.42	defun alistSize . . . . .	299
5.5.43	defun getSignatureFromMode . . . . .	299
5.5.44	defun getSpecialCaseAssoc . . . . .	300
5.5.45	defun addArgumentConditions . . . . .	300



5.5.46	defun stripOffSubdomainConditions . . . . .	301
5.5.47	defun stripOffArgumentConditions . . . . .	302
5.5.48	defun getSignature . . . . .	302
5.5.49	defun checkAndDeclare . . . . .	304
5.5.50	defun hasSigInTargetCategory . . . . .	304
5.5.51	defun getArgumentMode . . . . .	305
5.5.52	defplist compElt plist . . . . .	306
5.5.53	defun compElt . . . . .	306
5.5.54	defplist compExit plist . . . . .	307
5.5.55	defun compExit . . . . .	308
5.5.56	defplist compHas plist . . . . .	308
5.5.57	defun compHas . . . . .	309
5.5.58	defun compHasFormat . . . . .	309
5.5.59	defun mkList . . . . .	310
5.5.60	defplist compIf plist . . . . .	310
5.5.61	defun compIf . . . . .	311
5.5.62	defun compFromIf . . . . .	312
5.5.63	defun canReturn . . . . .	312
5.5.64	defun compBoolean . . . . .	314
5.5.65	defun getSuccessEnvironment . . . . .	314
5.5.66	defun getInverseEnvironment . . . . .	316
5.5.67	defun getUnionMode . . . . .	317
5.5.68	defun isUnionMode . . . . .	317
5.5.69	defplist compImport plist . . . . .	318
5.5.70	defun compImport . . . . .	318
5.5.71	defplist compIs plist . . . . .	318
5.5.72	defun compIs . . . . .	318
5.5.73	defplist compJoin plist . . . . .	319
5.5.74	defun compJoin . . . . .	319
5.5.75	defun compForMode . . . . .	321
5.5.76	defplist compLambda plist . . . . .	321
5.5.77	defun compLambda . . . . .	321
5.5.78	defplist compLeave plist . . . . .	322
5.5.79	defun compLeave . . . . .	323
5.5.80	defplist compMacro plist . . . . .	323
5.5.81	defun compMacro . . . . .	323
5.5.82	defplist compPretend plist . . . . .	324
5.5.83	defun compPretend . . . . .	324
5.5.84	defplist compQuote plist . . . . .	325
5.5.85	defun compQuote . . . . .	326
5.5.86	defplist compReduce plist . . . . .	326
5.5.87	defun compReduce . . . . .	326
5.5.88	defun compReduce1 . . . . .	326
5.5.89	defplist compRepeatOrCollect plist . . . . .	328
5.5.90	defplist compRepeatOrCollect plist . . . . .	328
5.5.91	defun compRepeatOrCollect . . . . .	329

5.5.92	defplist compReturn plist . . . . .	331
5.5.93	defun compReturn . . . . .	331
5.5.94	defplist compSeq plist . . . . .	332
5.5.95	defun compSeq . . . . .	332
5.5.96	defun compSeq1 . . . . .	332
5.5.97	defun replaceExitEtc . . . . .	333
5.5.98	defun convertOrCroak . . . . .	334
5.5.99	defun compSeqItem . . . . .	334
5.5.100	defplist compSetq plist . . . . .	335
5.5.101	defplist compSetq plist . . . . .	335
5.5.102	defun compSetq . . . . .	335
5.5.103	defun compSetq1 . . . . .	335
5.5.104	defun uncons . . . . .	336
5.5.105	defun setqMultiple . . . . .	337
5.5.106	defun setqMultipleExplicit . . . . .	339
5.5.107	defun setqSetelt . . . . .	340
5.5.108	defun setqSingle . . . . .	340
5.5.109	defun NRTassocIndex . . . . .	342
5.5.110	defun assignError . . . . .	342
5.5.111	defun outputComp . . . . .	343
5.5.112	defun maxSuperType . . . . .	344
5.5.113	defun isDomainForm . . . . .	344
5.5.114	defun isDomainConstructorForm . . . . .	344
5.5.115	defplist compString plist . . . . .	345
5.5.116	defun compString . . . . .	345
5.5.117	defplist compSubDomain plist . . . . .	346
5.5.118	defun compSubDomain . . . . .	346
5.5.119	defun compSubDomain1 . . . . .	346
5.5.120	defun lispize . . . . .	347
5.5.121	defplist compSubsetCategory plist . . . . .	348
5.5.122	defun compSubsetCategory . . . . .	348
5.5.123	defplist compSuchthat plist . . . . .	348
5.5.124	defun compSuchthat . . . . .	349
5.5.125	defplist compVector plist . . . . .	349
5.5.126	defun compVector . . . . .	349
5.5.127	defplist compWhere plist . . . . .	350
5.5.128	defun compWhere . . . . .	350
5.6	Functions for coercion . . . . .	351
5.6.1	defun coerce . . . . .	351
5.6.2	defun coerceEasy . . . . .	352
5.6.3	defun coerceSubset . . . . .	353
5.6.4	defun coerceHard . . . . .	354
5.6.5	defun coerceExtraHard . . . . .	355
5.6.6	defun hasType . . . . .	356
5.6.7	defun coerceable . . . . .	356
5.6.8	defun coerceExit . . . . .	357

5.6.9	defplist compAtSign plist . . . . .	357
5.6.10	defun compAtSign . . . . .	357
5.6.11	defplist compCoerce plist . . . . .	358
5.6.12	defun compCoerce . . . . .	358
5.6.13	defun compCoerce1 . . . . .	359
5.6.14	defun coerceByModemap . . . . .	359
5.6.15	defun autoCoerceByModemap . . . . .	360
5.6.16	defun resolve . . . . .	361
5.6.17	defun mkUnion . . . . .	362
5.6.18	defun This orders Unions . . . . .	362
5.6.19	defun modeEqualSubst . . . . .	363
<b>6</b>	<b>Post Transformers</b>	<b>365</b>
6.1	Direct called postparse routines . . . . .	365
6.1.1	defun postTransform . . . . .	365
6.1.2	defun postTran . . . . .	366
6.1.3	defun postOp . . . . .	367
6.1.4	defun postAtom . . . . .	367
6.1.5	defun postTranList . . . . .	368
6.1.6	defun postScriptsForm . . . . .	368
6.1.7	defun postTranScripts . . . . .	368
6.1.8	defun postTransformCheck . . . . .	369
6.1.9	defun postcheck . . . . .	369
6.1.10	defun postError . . . . .	370
6.1.11	defun postForm . . . . .	370
6.2	Indirect called postparse routines . . . . .	371
6.2.1	defplist postAdd plist . . . . .	372
6.2.2	defun postAdd . . . . .	372
6.2.3	defun postCapsule . . . . .	373
6.2.4	defun postBlockItemList . . . . .	373
6.2.5	defun postBlockItem . . . . .	373
6.2.6	defplist postAtSign plist . . . . .	374
6.2.7	defun postAtSign . . . . .	374
6.2.8	defun postType . . . . .	375
6.2.9	defplist postBigFloat plist . . . . .	375
6.2.10	defun postBigFloat . . . . .	376
6.2.11	defplist postBlock plist . . . . .	376
6.2.12	defun postBlock . . . . .	376
6.2.13	defplist postCategory plist . . . . .	377
6.2.14	defun postCategory . . . . .	377
6.2.15	defun postCollect,finish . . . . .	377
6.2.16	defun postMakeCons . . . . .	378
6.2.17	defplist postCollect plist . . . . .	379
6.2.18	defun postCollect . . . . .	379
6.2.19	defun postIteratorList . . . . .	380
6.2.20	defplist postColon plist . . . . .	380

6.2.21	defun postColon . . . . .	381
6.2.22	defplist postColonColon plist . . . . .	381
6.2.23	defun postColonColon . . . . .	381
6.2.24	defplist postComma plist . . . . .	382
6.2.25	defun postComma . . . . .	382
6.2.26	defun comma2Tuple . . . . .	382
6.2.27	defun postFlatten . . . . .	382
6.2.28	defplist postConstruct plist . . . . .	383
6.2.29	defun postConstruct . . . . .	383
6.2.30	defun postTranSegment . . . . .	384
6.2.31	defplist postDef plist . . . . .	384
6.2.32	defun postDef . . . . .	384
6.2.33	defun postDefArgs . . . . .	386
6.2.34	defplist postExit plist . . . . .	386
6.2.35	defun postExit . . . . .	387
6.2.36	defplist postIf plist . . . . .	387
6.2.37	defun postIf . . . . .	387
6.2.38	defplist postin plist . . . . .	388
6.2.39	defun postin . . . . .	388
6.2.40	defun postInSeq . . . . .	388
6.2.41	defplist postIn plist . . . . .	389
6.2.42	defun postIn . . . . .	389
6.2.43	defplist postJoin plist . . . . .	389
6.2.44	defun postJoin . . . . .	390
6.2.45	defplist postMapping plist . . . . .	390
6.2.46	defun postMapping . . . . .	390
6.2.47	defplist postMDef plist . . . . .	391
6.2.48	defun postMDef . . . . .	391
6.2.49	defplist postPretend plist . . . . .	392
6.2.50	defun postPretend . . . . .	392
6.2.51	defplist postQUOTE plist . . . . .	392
6.2.52	defun postQUOTE . . . . .	393
6.2.53	defplist postReduce plist . . . . .	393
6.2.54	defun postReduce . . . . .	393
6.2.55	defplist postRepeat plist . . . . .	394
6.2.56	defun postRepeat . . . . .	394
6.2.57	defplist postScripts plist . . . . .	394
6.2.58	defun postScripts . . . . .	394
6.2.59	defplist postSemiColon plist . . . . .	395
6.2.60	defun postSemiColon . . . . .	395
6.2.61	defun postFlattenLeft . . . . .	395
6.2.62	defplist postSignature plist . . . . .	396
6.2.63	defun postSignature . . . . .	396
6.2.64	defun removeSuperfluousMapping . . . . .	396
6.2.65	defun killColons . . . . .	397
6.2.66	defplist postSlash plist . . . . .	397

6.2.67	defun postSlash . . . . .	397
6.2.68	defplist postTuple plist . . . . .	398
6.2.69	defun postTuple . . . . .	398
6.2.70	defplist postTupleCollect plist . . . . .	398
6.2.71	defun postTupleCollect . . . . .	398
6.2.72	defplist postWhere plist . . . . .	399
6.2.73	defun postWhere . . . . .	399
6.2.74	defplist postWith plist . . . . .	399
6.2.75	defun postWith . . . . .	400
6.3	Support routines . . . . .	400
6.3.1	defun setDefOp . . . . .	400
6.3.2	defun aplTran . . . . .	401
6.3.3	defun aplTran1 . . . . .	401
6.3.4	defun aplTranList . . . . .	403
6.3.5	defun hasAplExtension . . . . .	403
6.3.6	defun deepestExpression . . . . .	404
6.3.7	defun containsBang . . . . .	404
6.3.8	defun getScriptName . . . . .	404
6.3.9	defun decodeScripts . . . . .	405
<b>7</b>	<b>DEF forms</b>	<b>407</b>
7.0.10	defvar \$defstack . . . . .	407
7.0.11	defvar \$is-spill . . . . .	407
7.0.12	defvar \$is-spill-list . . . . .	407
7.0.13	defvar \$vl . . . . .	408
7.0.14	defvar \$is-gensymlist . . . . .	408
7.0.15	defvar \$initial-gensym . . . . .	408
7.0.16	defvar \$is-eqlist . . . . .	408
7.0.17	defun hackforis . . . . .	408
7.0.18	defun hackforis1 . . . . .	409
7.0.19	defun unTuple . . . . .	409
7.0.20	defun errhuh . . . . .	409
<b>8</b>	<b>PARSE forms</b>	<b>411</b>
8.1	The original meta specification . . . . .	411
8.2	The PARSE code . . . . .	416
8.2.1	defvar \$tmptok . . . . .	416
8.2.2	defvar \$tok . . . . .	416
8.2.3	defvar \$ParseMode . . . . .	417
8.2.4	defvar \$definition-name . . . . .	417
8.2.5	defvar \$lablasoc . . . . .	417
8.2.6	defun PARSE-NewExpr . . . . .	417
8.2.7	defun PARSE-Command . . . . .	418
8.2.8	defun PARSE-SpecialKeyword . . . . .	418
8.2.9	defun PARSE-SpecialCommand . . . . .	419
8.2.10	defun PARSE-TokenCommandTail . . . . .	419

8.2.11	defun PARSE-TokenOption . . . . .	420
8.2.12	defun PARSE-TokenList . . . . .	420
8.2.13	defun PARSE-CommandTail . . . . .	421
8.2.14	defun PARSE-PrimaryOrQM . . . . .	421
8.2.15	defun PARSE-Option . . . . .	422
8.2.16	defun PARSE-Statement . . . . .	422
8.2.17	defun PARSE-InfixWith . . . . .	423
8.2.18	defun PARSE-With . . . . .	423
8.2.19	defun PARSE-Category . . . . .	423
8.2.20	defun PARSE-Expression . . . . .	425
8.2.21	defun PARSE-Import . . . . .	425
8.2.22	defun PARSE-Expr . . . . .	426
8.2.23	defun PARSE-LedPart . . . . .	426
8.2.24	defun PARSE-NudPart . . . . .	426
8.2.25	defun PARSE-Operation . . . . .	427
8.2.26	defun PARSE-leftBindingPowerOf . . . . .	427
8.2.27	defun PARSE-rightBindingPowerOf . . . . .	428
8.2.28	defun PARSE-getSemanticForm . . . . .	428
8.2.29	defun PARSE-Prefix . . . . .	428
8.2.30	defun PARSE-Infix . . . . .	429
8.2.31	defun PARSE-TokTail . . . . .	430
8.2.32	defun PARSE-Qualification . . . . .	430
8.2.33	defun PARSE-Reduction . . . . .	431
8.2.34	defun PARSE-ReductionOp . . . . .	431
8.2.35	defun PARSE-Form . . . . .	431
8.2.36	defun PARSE-Application . . . . .	432
8.2.37	defun PARSE-Label . . . . .	433
8.2.38	defun PARSE-Selector . . . . .	433
8.2.39	defun PARSE-PrimaryNoFloat . . . . .	434
8.2.40	defun PARSE-Primary . . . . .	434
8.2.41	defun PARSE-Primary1 . . . . .	434
8.2.42	defun PARSE-Float . . . . .	435
8.2.43	defun PARSE-FloatBase . . . . .	436
8.2.44	defun PARSE-FloatBasePart . . . . .	436
8.2.45	defun PARSE-FloatExponent . . . . .	437
8.2.46	defun PARSE-Enclosure . . . . .	438
8.2.47	defun PARSE-IntegerTok . . . . .	438
8.2.48	defun PARSE-FormalParameter . . . . .	439
8.2.49	defun PARSE-FormalParameterTok . . . . .	439
8.2.50	defun PARSE-Quad . . . . .	439
8.2.51	defun PARSE-String . . . . .	439
8.2.52	defun PARSE-VarForm . . . . .	440
8.2.53	defun PARSE-Scripts . . . . .	440
8.2.54	defun PARSE-ScriptItem . . . . .	441
8.2.55	defun PARSE-Name . . . . .	441
8.2.56	defun PARSE-Data . . . . .	442

8.2.57	defun PARSE-Sexpr . . . . .	442
8.2.58	defun PARSE-Sexpr1 . . . . .	442
8.2.59	defun PARSE-NBGlyphTok . . . . .	443
8.2.60	defun PARSE-GlyphTok . . . . .	444
8.2.61	defun PARSE-AnyId . . . . .	444
8.2.62	defun PARSE-Sequence . . . . .	445
8.2.63	defun PARSE-Sequence1 . . . . .	445
8.2.64	defun PARSE-OpenBracket . . . . .	446
8.2.65	defun PARSE-OpenBrace . . . . .	446
8.2.66	defun PARSE-IteratorTail . . . . .	447
8.2.67	defun PARSE-Iterator . . . . .	447
8.2.68	The PARSE implicit routines . . . . .	448
8.2.69	defun PARSE-Suffix . . . . .	448
8.2.70	defun PARSE-SemiColon . . . . .	449
8.2.71	defun PARSE-Return . . . . .	449
8.2.72	defun PARSE-Exit . . . . .	449
8.2.73	defun PARSE-Leave . . . . .	450
8.2.74	defun PARSE-Seg . . . . .	450
8.2.75	defun PARSE-Conditional . . . . .	451
8.2.76	defun PARSE-ElseClause . . . . .	451
8.2.77	defun PARSE-Loop . . . . .	452
8.2.78	defun PARSE-LabelExpr . . . . .	452
8.2.79	defun PARSE-FloatTok . . . . .	453
8.3	The PARSE support routines . . . . .	453
8.3.1	String grabbing . . . . .	454
8.3.2	defun match-string . . . . .	454
8.3.3	defun skip-blanks . . . . .	454
8.3.4	defun token-lookahead-type . . . . .	455
8.3.5	defun match-advance-string . . . . .	455
8.3.6	defun initial-substring-p . . . . .	456
8.3.7	defun quote-if-string . . . . .	456
8.3.8	defun escape-keywords . . . . .	457
8.3.9	defun isTokenDelimiter . . . . .	457
8.3.10	defun underscore . . . . .	458
8.3.11	Token Handling . . . . .	458
8.3.12	defun getToken . . . . .	458
8.3.13	defun unget-tokens . . . . .	458
8.3.14	defun match-current-token . . . . .	459
8.3.15	defun match-token . . . . .	460
8.3.16	defun match-next-token . . . . .	460
8.3.17	defun current-symbol . . . . .	460
8.3.18	defun make-symbol-of . . . . .	460
8.3.19	defun current-token . . . . .	461
8.3.20	defun try-get-token . . . . .	461
8.3.21	defun next-token . . . . .	462
8.3.22	defun advance-token . . . . .	462

8.3.23	defvar \$XTokenReader . . . . .	463
8.3.24	defun get-token . . . . .	463
8.3.25	Character handling . . . . .	463
8.3.26	defun current-char . . . . .	463
8.3.27	defun next-char . . . . .	463
8.3.28	defun char-eq . . . . .	464
8.3.29	defun char-ne . . . . .	464
8.3.30	Error handling . . . . .	464
8.3.31	defvar \$meta-error-handler . . . . .	464
8.3.32	defun meta-syntax-error . . . . .	465
8.3.33	Floating Point Support . . . . .	465
8.3.34	defun floatexpid . . . . .	465
8.3.35	Dollar Translation . . . . .	465
8.3.36	defun dollarTran . . . . .	465
8.3.37	Applying metagrammatical elements of a production (e.g., Star). . . .	466
8.3.38	defmacro Bang . . . . .	466
8.3.39	defmacro must . . . . .	466
8.3.40	defun action . . . . .	467
8.3.41	defun optional . . . . .	467
8.3.42	defmacro star . . . . .	467
8.3.43	Stacking and retrieving reductions of rules. . . . .	468
8.3.44	defvar \$reduce-stack . . . . .	468
8.3.45	defmacro reduce-stack-clear . . . . .	468
8.3.46	defun push-reduction . . . . .	468
<b>9</b>	<b>Comment Recording</b>	<b>469</b>
9.1	Comment Recording Layer 0 – API . . . . .	470
9.1.1	defun recordSignatureDocumentation . . . . .	470
9.1.2	defun recordAttributeDocumentation . . . . .	470
9.2	Comment Recording Layer 1 . . . . .	471
9.2.1	defun recordDocumentation . . . . .	471
9.3	Comment Recording Layer 2 . . . . .	471
9.3.1	defun collectComBlock . . . . .	471
9.4	Comment Recording Layer 3 . . . . .	472
9.4.1	defun recordHeaderDocumentation . . . . .	472
9.4.2	defun collectAndDeleteAssoc . . . . .	472
<b>10</b>	<b>Category handling</b>	<b>475</b>
10.0.3	defun getConstructorExports . . . . .	475
<b>11</b>	<b>Building libdb.text</b>	<b>477</b>
11.0.4	defun extendLocalLibdb . . . . .	477
11.0.5	defun buildLibdb . . . . .	478
11.0.6	defun buildLibdbString . . . . .	480
11.0.7	defun dbReadLines . . . . .	481
11.0.8	defun purgeNewConstructorLines . . . . .	481



11.0.9 defun dbWriteLines . . . . .	481
11.0.10 defun buildLibdbConEntry . . . . .	482
11.0.11 defun buildLibOps . . . . .	484
11.0.12 defun buildLibOp . . . . .	484
11.0.13 defun buildLibAttrs . . . . .	485
11.0.14 defun buildLibAttr . . . . .	485
11.0.15 defun screenLocalLine . . . . .	486
<b>12 Comment Syntax Checking</b>	<b>487</b>
12.1 Comment Checking Layer 0 – API . . . . .	492
12.1.1 defun finalizeDocumentation . . . . .	492
12.2 Comment Checking Layer 1 . . . . .	495
12.2.1 defun transDocList . . . . .	495
12.3 Comment Checking Layer 2 . . . . .	496
12.3.1 defun transDoc . . . . .	496
12.4 Comment Checking Layer 3 . . . . .	497
12.4.1 defun transformAndRecheckComments . . . . .	497
12.5 Comment Checking Layer 4 . . . . .	498
12.5.1 defun checkComments . . . . .	498
12.5.2 defun checkRewrite . . . . .	499
12.6 Comment Checking Layer 5 . . . . .	501
12.6.1 defun checkArguments . . . . .	501
12.6.2 defun checkBalance . . . . .	501
12.7 Comment Checking Layer 6 . . . . .	502
12.7.1 defun checkBeginEnd . . . . .	502
12.7.2 defun checkDecorate . . . . .	504
12.7.3 defun checkDecorateForHt . . . . .	506
12.7.4 defun checkDocError1 . . . . .	507
12.7.5 defun checkFixCommonProblem . . . . .	508
12.7.6 defun checkGetLispFunctionName . . . . .	508
12.7.7 defun checkHTargs . . . . .	509
12.7.8 defun checkRecordHash . . . . .	509
12.7.9 defun checkTexht . . . . .	512
12.7.10 defun checkTransformFirsts . . . . .	513
12.7.11 defun checkTrim . . . . .	516
12.8 Comment Checking Layer 7 . . . . .	517
12.8.1 defun checkDocError . . . . .	517
12.8.2 defun checkRemoveComments . . . . .	518
12.8.3 defun checkSkipToken . . . . .	518
12.8.4 defun checkSplit2Words . . . . .	518
12.9 Comment Checking Layer 8 . . . . .	519
12.9.1 defun checkAddIndented . . . . .	519
12.9.2 defun checkDocMessage . . . . .	519
12.9.3 defun checkExtract . . . . .	520
12.9.4 defun checkGetArgs . . . . .	521
12.9.5 defun checkGetMargin . . . . .	522

12.9.6	defun checkGetParse . . . . .	522
12.9.7	defun checkGetStringBeforeRightBrace . . . . .	523
12.9.8	defun checkIeEg . . . . .	523
12.9.9	defun checkIndentedLines . . . . .	524
12.9.10	defun checkSkipIdentifierToken . . . . .	525
12.9.11	defun checkSkipOpToken . . . . .	525
12.9.12	defun checkSplitBrace . . . . .	525
12.9.13	defun checkTrimCommented . . . . .	526
12.9.14	defun newString2Words . . . . .	527
12.10	Comment Checking Layer 9 . . . . .	527
12.10.1	defun checkAddBackSlashes . . . . .	527
12.10.2	defun checkAddMacros . . . . .	528
12.10.3	defun checkAddPeriod . . . . .	529
12.10.4	defun checkAddSpaceSegments . . . . .	529
12.10.5	defun checkAddSpaces . . . . .	530
12.10.6	defun checkAlphabetic . . . . .	531
12.10.7	defun checkIeEgfun . . . . .	531
12.10.8	defun checkIsValidType . . . . .	532
12.10.9	defun checkLookForLeftBrace . . . . .	533
12.10.10	defun checkLookForRightBrace . . . . .	533
12.10.11	defun checkNumOfArgs . . . . .	534
12.10.12	defun checkSayBracket . . . . .	534
12.10.13	defun checkSkipBlanks . . . . .	534
12.10.14	defun checkSplitBackslash . . . . .	535
12.10.15	defun checkSplitOn . . . . .	536
12.10.16	defun checkSplitPunctuation . . . . .	537
12.10.17	defun firstNonBlankPosition . . . . .	538
12.10.18	defun getMatchingRightPren . . . . .	538
12.10.19	defun hasNoVowels . . . . .	539
12.10.20	defun htcharPosition . . . . .	539
12.10.21	defun newWordFrom . . . . .	540
12.10.22	defun removeBackslashes . . . . .	541
12.10.23	defun whoOwns . . . . .	541
<b>13</b>	<b>Utility Functions</b>	<b>543</b>
13.0.24	defun translablel . . . . .	543
13.0.25	defun translablel1 . . . . .	543
13.0.26	defun displayPreCompilationErrors . . . . .	544
13.0.27	defun bumperrorcount . . . . .	545
13.0.28	defun parseTranCheckForRecord . . . . .	545
13.0.29	defun makeSimplePredicateOrNil . . . . .	546
13.0.30	defun parse-spadstring . . . . .	546
13.0.31	defun parse-string . . . . .	546
13.0.32	defun parse-identifier . . . . .	547
13.0.33	defun parse-number . . . . .	547
13.0.34	defun parse-keyword . . . . .	548

13.0.35 defun parse-argument-designator . . . . .	548
13.0.36 defun print-package . . . . .	549
13.0.37 defun checkWarning . . . . .	549
13.0.38 defun tuple2List . . . . .	549
13.0.39 defmacro pop-stack-1 . . . . .	550
13.0.40 defmacro pop-stack-2 . . . . .	550
13.0.41 defmacro pop-stack-3 . . . . .	551
13.0.42 defmacro pop-stack-4 . . . . .	551
13.0.43 defmacro nth-stack . . . . .	551
13.0.44 defun Pop-Reduction . . . . .	552
13.0.45 defun addclose . . . . .	552
13.0.46 defun blankp . . . . .	552
13.0.47 defun drop . . . . .	553
13.0.48 defun escaped . . . . .	553
13.0.49 defvar \$comblocklist . . . . .	553
13.0.50 defun fincomblock . . . . .	553
13.0.51 defun indent-pos . . . . .	554
13.0.52 defun infixtok . . . . .	555
13.0.53 defun is-console . . . . .	555
13.0.54 defun next-tab-loc . . . . .	555
13.0.55 defun nonblankloc . . . . .	555
13.0.56 defun parseprint . . . . .	556
13.0.57 defun skip-to-endif . . . . .	556
<b>14 The Compiler</b>	<b>557</b>
14.0.58 defvar \$newConlist . . . . .	557
14.1 Compiling EQ.spad . . . . .	557
14.2 The top level compiler command . . . . .	560
14.2.1 defun compiler . . . . .	562
14.2.2 defun compileSpad2Cmd . . . . .	565
14.2.3 defun compileSpadLispCmd . . . . .	568
14.2.4 compilerDoitWithScreenedLisplib . . . . .	569
14.2.5 defun compilerDoit . . . . .	570
14.2.6 defun /rq . . . . .	571
14.2.7 defun /rf . . . . .	571
14.2.8 defun /RQ,LIB . . . . .	572
14.2.9 defun /rf-1 . . . . .	572
14.2.10 defun spad . . . . .	573
14.2.11 defun Interpreter interface to the compiler . . . . .	576
14.2.12 defun compTopLevel . . . . .	586
14.2.13 defun print-defun . . . . .	587
14.2.14 defun def-rename . . . . .	587
14.2.15 defun compOrCroak . . . . .	588
14.2.16 defun compOrCroak1 . . . . .	589
14.2.17 defun comp . . . . .	590
14.2.18 defun compNoStacking . . . . .	590

14.2.19 defun compNoStacking1 . . . . .	591
14.2.20 defun comp2 . . . . .	591
14.2.21 defun comp3 . . . . .	592
14.2.22 defun applyMapping . . . . .	593
14.2.23 defun compApply . . . . .	595
14.2.24 defun compTypeOf . . . . .	596
14.2.25 defun compColonInside . . . . .	596
14.2.26 defun compAtom . . . . .	597
14.2.27 defun compAtomWithModemap . . . . .	598
14.2.28 defun transImplementation . . . . .	599
14.2.29 defun convert . . . . .	600
14.2.30 defun primitiveType . . . . .	600
14.2.31 defun compSymbol . . . . .	600
14.2.32 defun compList . . . . .	602
14.2.33 defun compForm . . . . .	602
14.2.34 defun compForm1 . . . . .	603
14.2.35 defun compToApply . . . . .	605
14.2.36 defun compApplication . . . . .	605
14.2.37 defun getFormModemaps . . . . .	607
14.2.38 defun eltModemapFilter . . . . .	608
14.2.39 defun seteltModemapFilter . . . . .	609
14.2.40 defun compExpressionList . . . . .	609
14.2.41 defun compForm2 . . . . .	610
14.2.42 defun compForm3 . . . . .	612
14.2.43 defun compFocompFormWithModemap . . . . .	613
14.2.44 defun substituteIntoFunctorModemap . . . . .	614
14.2.45 defun compFormPartiallyBottomUp . . . . .	615
14.2.46 defun compFormMatch . . . . .	615
14.2.47 defun compUniquely . . . . .	616
14.2.48 defun compArgumentsAndTryAgain . . . . .	616
14.2.49 defun compWithMappingMode . . . . .	617
14.2.50 defun compWithMappingMode1 . . . . .	617
14.2.51 defun extractCodeAndConstructTriple . . . . .	622
14.2.52 defun hasFormalMapVariable . . . . .	623
14.2.53 defun argsToSig . . . . .	623
14.2.54 defun compMakeDeclaration . . . . .	624
14.2.55 defun modifyModeStack . . . . .	625
14.2.56 defun Create a list of unbound symbols . . . . .	625
14.2.57 defun compOrCroak1,compactify . . . . .	626
14.2.58 defun Compiler/Interpreter interface . . . . .	627
14.2.59 defun recompile-lib-file-if-necessary . . . . .	627
14.2.60 defun spad-fixed-arg . . . . .	627
14.2.61 defun compile-lib-file . . . . .	628
14.2.62 defun compileFileQuietly . . . . .	628
14.2.63 defvar \$byConstructors . . . . .	629
14.2.64 defvar \$constructorsSeen . . . . .	629

<b>15 Level 1</b>	<b>631</b>
15.0.65 defvar \$current-fragment . . . . .	631
15.0.66 defun read-a-line . . . . .	631
<b>16 Level 0</b>	<b>633</b>
16.1 Line Handling . . . . .	633
16.1.1 Line Buffer . . . . .	633
16.1.2 defstruct \$line . . . . .	633
16.1.3 defvar \$current-line . . . . .	634
16.1.4 defmacro line-clear . . . . .	634
16.1.5 defun line-print . . . . .	634
16.1.6 defun line-at-end-p . . . . .	634
16.1.7 defun line-past-end-p . . . . .	635
16.1.8 defun line-next-char . . . . .	635
16.1.9 defun line-advance-char . . . . .	635
16.1.10 defun line-current-segment . . . . .	636
16.1.11 defun line-new-line . . . . .	636
16.1.12 defun next-line . . . . .	636
16.1.13 defun Advance-Char . . . . .	637
16.1.14 defun storeblanks . . . . .	637
16.1.15 defun initial-substring . . . . .	637
16.1.16 defun get-a-line . . . . .	638
<b>17 The Chunks</b>	<b>639</b>
<b>18 Index</b>	<b>657</b>

## Volume 10: Axiom Algebra: Implementation

<b>1</b>	<b>Implementation</b>	<b>1</b>
1.1	Elementary Functions[?] . . . . .	1
1.1.1	Rationale for Branch Cuts and Identities . . . . .	1
1.1.2	Inverse trigonometric functions . . . . .	3
1.1.3	Inverse hyperbolic functions . . . . .	4

## Volume 10.1: Axiom Algebra: Theory

<b>1</b>	<b>Integration</b>	<b>1</b>
1.1	Rational Functions . . . . .	2
1.1.1	The full partial-fraction algorithm . . . . .	2
1.1.2	The Hermite reduction . . . . .	3
1.1.3	The Rothstein-Trager and Lazard-Rioboo-Trager algorithms . . . . .	5
1.2	Algebraic Functions . . . . .	5
1.2.1	The Hermite reduction . . . . .	6
1.2.2	Simple radical extensions . . . . .	10
1.2.3	Liouville's Theorem . . . . .	12
1.2.4	The integral part . . . . .	12
1.2.5	The logarithmic part . . . . .	14
1.3	Elementary Functions . . . . .	16
1.3.1	Differential algebra . . . . .	17
1.3.2	The Hermite reduction . . . . .	18
1.3.3	The polynomial reduction . . . . .	19
1.3.4	The residue criterion . . . . .	20
1.3.5	The transcendental logarithmic case . . . . .	22
1.3.6	The transcendental exponential case . . . . .	23
1.3.7	The transcendental tangent case . . . . .	24
1.3.8	The algebraic logarithmic case . . . . .	24
1.3.9	The algebraic exponential case . . . . .	27
<b>2</b>	<b>Singular Value Decomposition</b>	<b>31</b>
2.1	Singular Value Decomposition Tutorial . . . . .	31
<b>3</b>	<b>Quaternions</b>	<b>37</b>
	Preface . . . . .	37
3.1	Quaternions . . . . .	38
3.2	Vectors, and their Composition . . . . .	38
3.3	Examples To Chapter 1. . . . .	65
3.4	Products And Quotients of Vectors . . . . .	67
3.5	Examples To Chapter 2. . . . .	93
3.6	Interpretations And Transformations . . . . .	94
3.7	Examples to Chapter 3 . . . . .	124
3.8	Axiom Examples . . . . .	130
<b>4</b>	<b>Clifford Algebra[?]</b>	<b>133</b>
4.1	Introduction . . . . .	133
4.2	Clifford Basis Matrix Theory . . . . .	134
4.3	Calculation of the inverse of a Clifford number . . . . .	136
4.3.1	Example 1: Clifford (2) . . . . .	137
4.3.2	Example 2: Clifford (3) . . . . .	137
4.3.3	Example 3: Clifford (2,2) . . . . .	139

4.3.4 Conclusion . . . . .	142
<b>5 Package for Algebraic Function Fields</b>	<b>143</b>
<b>6 Groebner Basis</b>	<b>145</b>
<b>7 Greatest Common Divisor</b>	<b>147</b>
<b>8 Polynomial Factorization</b>	<b>149</b>
<b>9 Cylindrical Algebraic Decomposition</b>	<b>151</b>
<b>10 Pade approximant</b>	<b>153</b>
<b>11 Schwartz-Zippel lemma and testing polynomial identities</b>	<b>155</b>
<b>12 Chinese Remainder Theorem</b>	<b>157</b>
<b>13 Gaussian Elimination</b>	<b>159</b>
<b>14 Diophantine Equations</b>	<b>161</b>
<b>15 Index</b>	<b>167</b>



## Volume 10.2: Axiom Algebra: Categories

<b>1</b>	<b>Categories</b>	<b>1</b>
<b>2</b>	<b>Category Layer 1</b>	<b>3</b>
2.0.1	Category (CATEGORY) . . . . .	3
2.0.2	ArcHyperbolicFunctionCategory (AHYP) . . . . .	5
2.0.3	ArcTrigonometricFunctionCategory (ATRIG) . . . . .	7
2.0.4	AttributeRegistry (ATTREG) . . . . .	10
2.0.5	BasicType (BASTYPE) . . . . .	14
2.0.6	CoercibleTo (KOERCE) . . . . .	17
2.0.7	CombinatorialFunctionCategory (CFCAT) . . . . .	20
2.0.8	ConvertibleTo (KONVERT) . . . . .	23
2.0.9	ElementaryFunctionCategory (ELEMFUN) . . . . .	27
2.0.10	Eltable (ELTAB) . . . . .	29
2.0.11	HyperbolicFunctionCategory (HYPCAT) . . . . .	32
2.0.12	InnerEvaluable (IEVALAB) . . . . .	35
2.0.13	OpenMath (OM) . . . . .	39
2.0.14	PartialTranscendentalFunctions (PTRANFN) . . . . .	42
2.0.15	Patternable (PATAB) . . . . .	47
2.0.16	PrimitiveFunctionCategory (PRIMCAT) . . . . .	50
2.0.17	RadicalCategory (RADCAT) . . . . .	52
2.0.18	RetractableTo (RETRACT) . . . . .	55
2.0.19	SpecialFunctionCategory (SPFCAT) . . . . .	59
2.0.20	TrigonometricFunctionCategory (TRIGCAT) . . . . .	63
2.0.21	Type (TYPE) . . . . .	66
<b>3</b>	<b>Category Layer 2</b>	<b>69</b>
3.0.22	Aggregate (AGG) . . . . .	69
3.0.23	CombinatorialOpsCategory (COMBOPC) . . . . .	73
3.0.24	EltableAggregate (ELTAGG) . . . . .	76
3.0.25	Evaluable (EVALAB) . . . . .	80
3.0.26	FortranProgramCategory (FORTCAT) . . . . .	84
3.0.27	FullyRetractableTo (FRETRCT) . . . . .	87
3.0.28	FullyPatternMatchable (FPATMAB) . . . . .	91
3.0.29	Logic (LOGIC) . . . . .	95
3.0.30	PlottablePlaneCurveCategory (PPCURVE) . . . . .	98
3.0.31	PlottableSpaceCurveCategory (PSCURVE) . . . . .	102
3.0.32	RealConstant (REAL) . . . . .	106
3.0.33	SegmentCategory (SEGCAT) . . . . .	109
3.0.34	SetCategory (SETCAT) . . . . .	113
3.0.35	TranscendentalFunctionCategory (TRANFUN) . . . . .	117

<b>4</b>	<b>Category Layer 3</b>	<b>123</b>
4.0.36	AbelianSemiGroup (ABELSG)	123
4.0.37	BlowUpMethodCategory (BLMETCT)	127
4.0.38	DesingTreeCategory (DSTRCAT)	131
4.0.39	FortranFunctionCategory (FORTFN)	136
4.0.40	FortranMatrixCategory (FMC)	141
4.0.41	FortranMatrixFunctionCategory (FMFUN)	145
4.0.42	FortranVectorCategory (FVC)	150
4.0.43	FortranVectorFunctionCategory (FVFUN)	154
4.0.44	FullyEvaluableOver (FEVALAB)	159
4.0.45	FileCategory (FILECAT)	163
4.0.46	Finite (FINITE)	168
4.0.47	FileNameCategory (FNCAT)	172
4.0.48	GradedModule (GRMOD)	176
4.0.49	HomogeneousAggregate (HOAGG)	181
4.0.50	IndexedDirectProductCategory (IDPC)	188
4.0.51	LiouvillianFunctionCategory (LFCAT)	192
4.0.52	Monad (MONAD)	197
4.0.53	NumericalIntegrationCategory (NUMINT)	202
4.0.54	NumericalOptimizationCategory (OPTCAT)	207
4.0.55	OrdinaryDifferentialEquationsSolverCategory (ODECAT)	212
4.0.56	OrderedSet (ORDSET)	216
4.0.57	PartialDifferentialEquationsSolverCategory (PDECAT)	221
4.0.58	PatternMatchable (PATMAB)	226
4.0.59	RealRootCharacterizationCategory (RRCC)	230
4.0.60	SegmentExpansionCategory (SEGXCAT)	235
4.0.61	SemiGroup (SGROUP)	239
4.0.62	SetCategoryWithDegree (SETCATD)	243
4.0.63	SExpressionCategory (SEXCAT)	246
4.0.64	StepThrough (STEP)	252
4.0.65	ThreeSpaceCategory (SPACEC)	256
<b>5</b>	<b>Category Layer 4</b>	<b>267</b>
5.0.66	AbelianMonoid (ABELMON)	267
5.0.67	AffineSpaceCategory (AFSPCAT)	272
5.0.68	BagAggregate (BGAGG)	277
5.0.69	CachableSet (CACHSET)	283
5.0.70	Collection (CLAGG)	287
5.0.71	DifferentialVariableCategory (DVARCAT)	294
5.0.72	ExpressionSpace (ES)	300
5.0.73	GradedAlgebra (GRALG)	313
5.0.74	IndexedAggregate (IXAGG)	318
5.0.75	MonadWithUnit (MONADWU)	325
5.0.76	Monoid (MONOID)	331
5.0.77	OrderedFinite (ORDFIN)	336
5.0.78	PlacesCategory (PLACESC)	340

5.0.79	ProjectiveSpaceCategory (PRSPCAT)	345
5.0.80	RecursiveAggregate (RCAGG)	351
5.0.81	TwoDimensionalArrayCategory (ARR2CAT)	357
<b>6</b>	<b>Category Layer 5</b>	<b>371</b>
6.0.82	BinaryRecursiveAggregate (BRAGG)	372
6.0.83	CancellationAbelianMonoid (CABMON)	380
6.0.84	DictionaryOperations (DIOPS)	385
6.0.85	DoublyLinkedAggregate (DLAGG)	392
6.0.86	Group (GROUP)	398
6.0.87	LinearAggregate (LNAGG)	404
6.0.88	MatrixCategory (MATCAT)	412
6.0.89	OrderedAbelianSemiGroup (OASGP)	456
6.0.90	OrderedMonoid (ORDMON)	461
6.0.91	PolynomialSetCategory (PSETCAT)	465
6.0.92	PriorityQueueAggregate (PRQAGG)	480
6.0.93	QueueAggregate (QUAGG)	486
6.0.94	SetAggregate (SETAGG)	492
6.0.95	StackAggregate (SKAGG)	500
6.0.96	UnaryRecursiveAggregate (URAGG)	506
<b>7</b>	<b>Category Layer 6</b>	<b>519</b>
7.0.97	AbelianGroup (ABELGRP)	520
7.0.98	BinaryTreeCategory (BTCAT)	526
7.0.99	Dictionary (DIAGG)	533
7.0.100	DequeueAggregate (DQAGG)	540
7.0.101	ExtensibleLinearAggregate (ELAGG)	547
7.0.102	FiniteLinearAggregate (FLAGG)	555
7.0.103	FreeAbelianMonoidCategory (FAMONC)	564
7.0.104	MultiDictionary (MDAGG)	570
7.0.105	OrderedAbelianMonoid (OAMON)	576
7.0.106	PermutationCategory (PERMCAT)	580
7.0.107	StreamAggregate (STAGG)	585
7.0.108	TriangularSetCategory (TSETCAT)	595
<b>8</b>	<b>Category Layer 7</b>	<b>615</b>
8.0.109	FiniteDivisorCategory (FDIVCAT)	616
8.0.110	FiniteSetAggregate (FSAGG)	621
8.0.111	KeyedDictionary (KDAGG)	630
8.0.112	LazyStreamAggregate (LZSTAGG)	637
8.0.113	LeftModule (LMODULE)	655
8.0.114	ListAggregate (LSAGG)	659
8.0.115	MultisetAggregate (MSETAGG)	673
8.0.116	NonAssociativeRng (NARNG)	679
8.0.117	OneDimensionalArrayAggregate (A1AGG)	684
8.0.118	OrderedCancellationAbelianMonoid (OCAMON)	696

8.0.119 RegularTriangularSetCategory (RSETCAT) . . . . .	700
8.0.120 RightModule (RMODULE) . . . . .	715
8.0.121 Rng (RNG) . . . . .	719
<b>9 Category Layer 8</b>	<b>725</b>
9.0.122 BiModule (BMODULE) . . . . .	726
9.0.123 BitAggregate (BTAGG) . . . . .	731
9.0.124 NonAssociativeRing (NASRING) . . . . .	740
9.0.125 NormalizedTriangularSetCategory (NTSCAT) . . . . .	745
9.0.126 OrderedAbelianGroup (OAGROUP) . . . . .	755
9.0.127 OrderedAbelianMonoidSup (OAMONS) . . . . .	759
9.0.128 OrderedMultisetAggregate (OMSAGG) . . . . .	763
9.0.129 Ring (RING) . . . . .	770
9.0.130 SquareFreeRegularTriangularSetCategory (SFRTCAT) . . . . .	775
9.0.131 StringAggregate (SRAGG) . . . . .	786
9.0.132 TableAggregate (TBAGG) . . . . .	797
9.0.133 VectorCategory (VECTCAT) . . . . .	808
<b>10 Category Layer 9</b>	<b>819</b>
10.0.134 AssociationListAggregate (ALAGG) . . . . .	819
10.0.135 CharacteristicNonZero (CHARNZ) . . . . .	833
10.0.136 CharacteristicZero (CHARZ) . . . . .	838
10.0.137 CommutativeRing (COMRING) . . . . .	843
10.0.138 DifferentialRing (DIFRING) . . . . .	848
10.0.139 EntireRing (ENTIRER) . . . . .	853
10.0.140 FreeModuleCat (FMCAT) . . . . .	858
10.0.141 LeftAlgebra (LALG) . . . . .	864
10.0.142 LinearlyExplicitRingOver (LINEXP) . . . . .	869
10.0.143 Module (MODULE) . . . . .	874
10.0.144 OrderedRing (ORDRING) . . . . .	879
10.0.145 PartialDifferentialRing (PDRING) . . . . .	885
10.0.146 PointCategory (PTCAT) . . . . .	893
10.0.147 RectangularMatrixCategory (RMATCAT) . . . . .	901
10.0.148 SquareFreeNormalizedTriangularSetCategory (SNTSCAT) . . . . .	910
10.0.149 StringCategory (STRICAT) . . . . .	920
10.0.150 UnivariateSkewPolynomialCategory (OREPCAT) . . . . .	929
10.0.151 KAlgebra (XALG) . . . . .	940
<b>11 Category Layer 10</b>	<b>947</b>
11.0.152 Algebra (ALGEBRA) . . . . .	947
11.0.153 DifferentialExtension (DIFEXT) . . . . .	953
11.0.154 FullyLinearlyExplicitRingOver (FLINEXP) . . . . .	960
11.0.155 LieAlgebra (LIECAT) . . . . .	966
11.0.156 LinearOrdinaryDifferentialOperatorCategory (LODOCAT) . . . . .	971
11.0.157 NonAssociativeAlgebra (NAALG) . . . . .	980
11.0.158 VectorSpace (VSPACE) . . . . .	987

11.0.15	<del>X</del> FreeAlgebra (XFALG)	992
<b>12</b>	<b>Category Layer 11</b>	<b>1001</b>
12.0.16	<del>D</del> irectProductCategory (DIRPCAT)	1001
12.0.16	<del>D</del> ivisionRing (DIVRING)	1013
12.0.16	<del>F</del> initeRankNonAssociativeAlgebra (FINAALG)	1019
12.0.16	<del>F</del> reeLieAlgebra (FLALG)	1041
12.0.16	<del>I</del> ntegralDomain (INTDOM)	1047
12.0.16	<del>M</del> onogenicLinearOperator (MLO)	1053
12.0.16	<del>O</del> ctonionCategory (OC)	1059
12.0.16	<del>Q</del> uaternionCategory (QUATCAT)	1071
12.0.16	<del>S</del> quareMatrixCategory (SMATCAT)	1082
12.0.16	<del>X</del> PolynomialsCat (XPOLYC)	1094
<b>13</b>	<b>Category Layer 12</b>	<b>1101</b>
13.0.17	<del>A</del> belianMonoidRing (AMR)	1101
13.0.17	<del>F</del> ortranMachineTypeCategory (FMTC)	1108
13.0.17	<del>F</del> ramedNonAssociativeAlgebra (FRNAALG)	1115
13.0.17	<del>G</del> cdDomain (GCDDOM)	1129
13.0.17	<del>O</del> rderedIntegralDomain (OINTDOM)	1135
<b>14</b>	<b>Category Layer 13</b>	<b>1141</b>
14.0.17	<del>F</del> initeAbelianMonoidRing (FAMR)	1141
14.0.17	<del>I</del> ntervalCategory (INTCAT)	1150
14.0.17	<del>P</del> owerSeriesCategory (PSCAT)	1159
14.0.17	<del>P</del> rincipalIdealDomain (PID)	1166
14.0.17	<del>U</del> niqueFactorizationDomain (UFD)	1172
<b>15</b>	<b>Category Layer 14</b>	<b>1179</b>
15.0.18	<del>D</del> ivisorCategory (DIVCAT)	1179
15.0.18	<del>E</del> uclideanDomain (EUCDOM)	1185
15.0.18	<del>M</del> ultivariateTaylorSeriesCategory (MTSCAT)	1193
15.0.18	<del>P</del> olynomialFactorizationExplicit (PFECAT)	1202
15.0.18	<del>U</del> nivariatePowerSeriesCategory (UPSCAT)	1210
<b>16</b>	<b>Category Layer 15</b>	<b>1221</b>
16.0.18	<del>F</del> ield (FIELD)	1221
16.0.18	<del>I</del> ntegerNumberSystem (INS)	1228
16.0.18	<del>L</del> ocalPowerSeriesCategory (LOCPOWC)	1239
16.0.18	<del>P</del> AdicIntegerCategory (PADICCT)	1249
16.0.18	<del>P</del> olynomialCategory (POLYCAT)	1255
16.0.19	<del>U</del> nivariateTaylorSeriesCategory (UTSCAT)	1277

<b>17 Category Layer 16</b>	<b>1293</b>
17.0.19AAlgebraicallyClosedField (ACF)	1293
17.0.19DDifferentialPolynomialCategory (DPOLCAT)	1306
17.0.19FFieldOfPrimeCharacteristic (FPC)	1323
17.0.19FFiniteRankAlgebra (FINRALG)	1329
17.0.19FFunctionSpace (FS)	1336
17.0.196InfinitelyClosePointCategory (INFCLCT)	1364
17.0.19TPseudoAlgebraicClosureOfPerfectFieldCategory (PACPERC)	1369
17.0.19QQuotientFieldCategory (QFCAT)	1376
17.0.199RealClosedField (RCFIELD)	1390
17.0.200RealNumberSystem (RNS)	1400
17.0.20RRecursivePolynomialCategory (RPOLCAT)	1408
17.0.20UUnivariateLaurentSeriesCategory (ULSCAT)	1448
17.0.20UUnivariatePuisseuxSeriesCategory (UPXSCAT)	1460
17.0.204UnivariatePolynomialCategory (UPOLYC)	1471
<b>18 Category Layer 17</b>	<b>1495</b>
18.0.205AlgebraicallyClosedFunctionSpace (ACFS)	1495
18.0.206ExtensionField (XF)	1510
18.0.20TFiniteFieldCategory (FFIELD)	1518
18.0.208FloatingPointSystem (FPS)	1530
18.0.209FramedAlgebra (FRAMALG)	1539
18.0.210PseudoAlgebraicClosureOfFiniteFieldCategory (PACFFC)	1546
18.0.21UUnivariateLaurentSeriesConstructorCategory (ULSCCAT)	1553
18.0.21UUnivariatePuisseuxSeriesConstructorCategory (UPXSCCA)	1570
<b>19 Category Layer 18</b>	<b>1583</b>
19.0.21FFiniteAlgebraicExtensionField (FAXF)	1583
19.0.21MMonogenicAlgebra (MONOGEN)	1598
19.0.21PPseudoAlgebraicClosureOfRationalNumberCategory (PACRATC)	1610
<b>20 Category Layer 19</b>	<b>1619</b>
20.0.21CComplexCategory (COMPCAT)	1619
20.0.21TFunctionFieldCategory (FFCAT)	1642
20.0.21PPseudoAlgebraicClosureOfAlgExtOfRationalNumberCategory (PACEXTC)	1665
<b>21 The bootstrap code</b>	<b>1675</b>
21.1 ABELGRP.lsp BOOTSTRAP	1675
21.2 ABELGRP-.lsp BOOTSTRAP	1676
21.3 ABELMON.lsp BOOTSTRAP	1678
21.4 ABELMON-.lsp BOOTSTRAP	1679
21.5 ABELSG.lsp BOOTSTRAP	1680
21.6 ABELSG-.lsp BOOTSTRAP	1681
21.7 ALAGG.lsp BOOTSTRAP	1683
21.8 CABMON.lsp BOOTSTRAP	1684
21.9 CLAGG.lsp BOOTSTRAP	1685

21.10	CLAGG-.lsp	BOOTSTRAP . . . . .	1687
21.11	COMRING.lsp	BOOTSTRAP . . . . .	1691
21.12	DIFRING.lsp	BOOTSTRAP . . . . .	1692
21.13	DIFRING-.lsp	BOOTSTRAP . . . . .	1693
21.14	DIVRING.lsp	BOOTSTRAP . . . . .	1695
21.15	DIVRING-.lsp	BOOTSTRAP . . . . .	1696
21.16	ES.lsp	BOOTSTRAP . . . . .	1698
21.17	ES-.lsp	BOOTSTRAP . . . . .	1700
21.18	EUCDOM.lsp	BOOTSTRAP . . . . .	1716
21.18.1	The Lisp Implementation . . . . .		1716
21.19	EUCDOM-.lsp	BOOTSTRAP . . . . .	1719
21.19.1	The Lisp Implementation . . . . .		1719
21.20	ENTIRER.lsp	BOOTSTRAP . . . . .	1732
21.21	FFIELD.lsp	BOOTSTRAP . . . . .	1733
21.22	FFIELD-.lsp	BOOTSTRAP . . . . .	1734
21.23	FPS.lsp	BOOTSTRAP . . . . .	1745
21.24	FPS-.lsp	BOOTSTRAP . . . . .	1747
21.25	GCDDOM.lsp	BOOTSTRAP . . . . .	1749
21.26	GCDDOM-.lsp	BOOTSTRAP . . . . .	1750
21.27	HOAGG.lsp	BOOTSTRAP . . . . .	1755
21.28	HOAGG-.lsp	BOOTSTRAP . . . . .	1757
21.29	INS.lsp	BOOTSTRAP . . . . .	1763
21.30	INS-.lsp	BOOTSTRAP . . . . .	1765
21.31	INTDOM.lsp	BOOTSTRAP . . . . .	1773
21.32	INTDOM-.lsp	BOOTSTRAP . . . . .	1774
21.33	LNAGG.lsp	BOOTSTRAP . . . . .	1776
21.34	LNAGG-.lsp	BOOTSTRAP . . . . .	1778
21.35	LSAGG.lsp	BOOTSTRAP . . . . .	1780
21.36	LSAGG-.lsp	BOOTSTRAP . . . . .	1781
21.37	MONOID.lsp	BOOTSTRAP . . . . .	1798
21.38	MONOID-.lsp	BOOTSTRAP . . . . .	1799
21.39	MTSCAT.lsp	BOOTSTRAP . . . . .	1801
21.40	OINTDOM.lsp	BOOTSTRAP . . . . .	1803
21.41	ORDRING.lsp	BOOTSTRAP . . . . .	1804
21.42	ORDRING-.lsp	BOOTSTRAP . . . . .	1805
21.43	POLYCAT.lsp	BOOTSTRAP . . . . .	1807
21.44	POLYCAT-.lsp	BOOTSTRAP . . . . .	1809
21.45	PSETCAT.lsp	BOOTSTRAP . . . . .	1840
21.46	PSETCAT-.lsp	BOOTSTRAP . . . . .	1842
21.47	QFCAT.lsp	BOOTSTRAP . . . . .	1859
21.48	QFCAT-.lsp	BOOTSTRAP . . . . .	1861
21.49	RCAGG.lsp	BOOTSTRAP . . . . .	1869
21.50	RCAGG-.lsp	BOOTSTRAP . . . . .	1871
21.51	RING.lsp	BOOTSTRAP . . . . .	1872
21.52	RING-.lsp	BOOTSTRAP . . . . .	1873
21.53	RNG.lsp	BOOTSTRAP . . . . .	1875

21.54RNS.lsp BOOTSTRAP . . . . .	1875
21.55RNS-.lsp BOOTSTRAP . . . . .	1877
21.56SETAGG.lsp BOOTSTRAP . . . . .	1881
21.57SETAGG-.lsp BOOTSTRAP . . . . .	1882
21.58SETCAT.lsp BOOTSTRAP . . . . .	1884
21.59SETCAT-.lsp BOOTSTRAP . . . . .	1885
21.60STAGG.lsp BOOTSTRAP . . . . .	1886
21.61STAGG-.lsp BOOTSTRAP . . . . .	1887
21.62TSETCAT.lsp BOOTSTRAP . . . . .	1894
21.63TSETCAT-.lsp BOOTSTRAP . . . . .	1897
21.64UFD.lsp BOOTSTRAP . . . . .	1917
21.65UFD-.lsp BOOTSTRAP . . . . .	1918
21.66ULSCAT.lsp BOOTSTRAP . . . . .	1921
21.67UPOLYC.lsp BOOTSTRAP . . . . .	1922
21.68UPOLYC-.lsp BOOTSTRAP . . . . .	1926
21.69URAGG.lsp BOOTSTRAP . . . . .	1953
21.70URAGG-.lsp BOOTSTRAP . . . . .	1955
<b>22 Chunk collections</b>	<b>1971</b>



## Volume 10.3: Axiom Algebra: Domains

<b>1</b>	<b>Chapter Overview</b>	<b>1</b>
<b>2</b>	<b>Chapter A</b>	<b>3</b>
2.1	domain AFFPL AffinePlane . . . . .	3
2.1.1	AffinePlane (AFFPL) . . . . .	4
2.2	domain AFFPLPS AffinePlaneOverPseudoAlgebraicClosureOfFiniteField . .	5
2.2.1	AffinePlaneOverPseudoAlgebraicClosureOfFiniteField (AFFPLPS) . .	7
2.3	domain AFFSP AffineSpace . . . . .	8
2.3.1	AffineSpace (AFFSP) . . . . .	9
2.4	domain ALGSC AlgebraGivenByStructuralConstants . . . . .	12
2.4.1	AlgebraGivenByStructuralConstants (ALGSC) . . . . .	14
2.5	domain ALGFF AlgebraicFunctionField . . . . .	23
2.5.1	AlgebraicFunctionField (ALGFF) . . . . .	27
2.6	domain AN AlgebraicNumber . . . . .	32
2.6.1	AlgebraicNumber (AN) . . . . .	35
2.7	domain ANON AnonymousFunction . . . . .	37
2.7.1	AnonymousFunction (ANON) . . . . .	38
2.8	domain ANTISYM AntiSymm . . . . .	38
2.8.1	AntiSymm (ANTISYM) . . . . .	40
2.9	domain ANY Any . . . . .	44
2.9.1	Any (ANY) . . . . .	50
2.10	domain ASTACK ArrayStack . . . . .	52
2.10.1	ArrayStack (ASTACK) . . . . .	65
2.11	domain ASP1 Asp1 . . . . .	69
2.11.1	Asp1 (ASP1) . . . . .	71
2.12	domain ASP10 Asp10 . . . . .	73
2.12.1	Asp10 (ASP10) . . . . .	75
2.13	domain ASP12 Asp12 . . . . .	78
2.13.1	Asp12 (ASP12) . . . . .	79
2.14	domain ASP19 Asp19 . . . . .	81
2.14.1	Asp19 (ASP19) . . . . .	82
2.15	domain ASP20 Asp20 . . . . .	88
2.15.1	Asp20 (ASP20) . . . . .	89
2.16	domain ASP24 Asp24 . . . . .	93
2.16.1	Asp24 (ASP24) . . . . .	94
2.17	domain ASP27 Asp27 . . . . .	97
2.17.1	Asp27 (ASP27) . . . . .	98
2.18	domain ASP28 Asp28 . . . . .	101
2.18.1	Asp28 (ASP28) . . . . .	102
2.19	domain ASP29 Asp29 . . . . .	106
2.19.1	Asp29 (ASP29) . . . . .	107
2.20	domain ASP30 Asp30 . . . . .	109
2.20.1	Asp30 (ASP30) . . . . .	110

2.21	domain ASP31 Asp31 . . . . .	113
2.21.1	Asp31 (ASP31) . . . . .	115
2.22	domain ASP33 Asp33 . . . . .	118
2.22.1	Asp33 (ASP33) . . . . .	119
2.23	domain ASP34 Asp34 . . . . .	121
2.23.1	Asp34 (ASP34) . . . . .	122
2.24	domain ASP35 Asp35 . . . . .	124
2.24.1	Asp35 (ASP35) . . . . .	126
2.25	domain ASP4 Asp4 . . . . .	130
2.25.1	Asp4 (ASP4) . . . . .	131
2.26	domain ASP41 Asp41 . . . . .	133
2.26.1	Asp41 (ASP41) . . . . .	135
2.27	domain ASP42 Asp42 . . . . .	139
2.27.1	Asp42 (ASP42) . . . . .	141
2.28	domain ASP49 Asp49 . . . . .	146
2.28.1	Asp49 (ASP49) . . . . .	147
2.29	domain ASP50 Asp50 . . . . .	151
2.29.1	Asp50 (ASP50) . . . . .	152
2.30	domain ASP55 Asp55 . . . . .	156
2.30.1	Asp55 (ASP55) . . . . .	157
2.31	domain ASP6 Asp6 . . . . .	162
2.31.1	Asp6 (ASP6) . . . . .	163
2.32	domain ASP7 Asp7 . . . . .	166
2.32.1	Asp7 (ASP7) . . . . .	168
2.33	domain ASP73 Asp73 . . . . .	171
2.33.1	Asp73 (ASP73) . . . . .	172
2.34	domain ASP74 Asp74 . . . . .	175
2.34.1	Asp74 (ASP74) . . . . .	177
2.35	domain ASP77 Asp77 . . . . .	181
2.35.1	Asp77 (ASP77) . . . . .	182
2.36	domain ASP78 Asp78 . . . . .	186
2.36.1	Asp78 (ASP78) . . . . .	187
2.37	domain ASP8 Asp8 . . . . .	190
2.37.1	Asp8 (ASP8) . . . . .	191
2.38	domain ASP80 Asp80 . . . . .	194
2.38.1	Asp80 (ASP80) . . . . .	195
2.39	domain ASP9 Asp9 . . . . .	199
2.39.1	Asp9 (ASP9) . . . . .	200
2.40	domain JORDAN AssociatedJordanAlgebra . . . . .	203
2.40.1	AssociatedJordanAlgebra (JORDAN) . . . . .	206
2.41	domain LIE AssociatedLieAlgebra . . . . .	209
2.41.1	AssociatedLieAlgebra (LIE) . . . . .	211
2.42	domain ALIST AssociationList . . . . .	214
2.42.1	AssociationList (ALIST) . . . . .	218
2.43	domain ATTRBUT AttributeButtons . . . . .	221
2.43.1	AttributeButtons (ATTRBUT) . . . . .	222

2.44	domain AUTOMOR Automorphism . . . . .	227
2.44.1	Automorphism (AUTOMOR) . . . . .	228
<b>3</b>	<b>Chapter B</b>	<b>231</b>
3.1	domain BBTREE BalancedBinaryTree . . . . .	231
3.1.1	BalancedBinaryTree (BBTREE) . . . . .	234
3.2	domain BPADIC BalancedPAdicInteger . . . . .	238
3.2.1	BalancedPAdicInteger (BPADIC) . . . . .	240
3.3	domain BPADICRT BalancedPAdicRational . . . . .	241
3.3.1	BalancedPAdicRational (BPADICRT) . . . . .	244
3.4	domain BFUNCT BasicFunctions . . . . .	246
3.4.1	BasicFunctions (BFUNCT) . . . . .	247
3.5	domain BOP BasicOperator . . . . .	249
3.5.1	BasicOperator (BOP) . . . . .	256
3.6	domain BSD BasicStochasticDifferential . . . . .	260
3.6.1	BasicStochasticDifferential (BSD) . . . . .	268
3.7	domain BINARY BinaryExpansion . . . . .	270
3.7.1	BinaryExpansion (BINARY) . . . . .	274
3.8	domain BINFILE BinaryFile . . . . .	276
3.8.1	BinaryFile (BINFILE) . . . . .	277
3.9	domain BSTREE BinarySearchTree . . . . .	280
3.9.1	BinarySearchTree (BSTREE) . . . . .	285
3.10	domain BTOURN BinaryTournament . . . . .	287
3.10.1	BinaryTournament (BTOURN) . . . . .	289
3.11	domain BTREE BinaryTree . . . . .	290
3.11.1	BinaryTree (BTREE) . . . . .	292
3.12	domain BITS Bits . . . . .	294
3.12.1	Bits (BITS) . . . . .	297
3.13	domain BLHN BlowUpWithHamburgerNoether . . . . .	298
3.13.1	BlowUpWithHamburgerNoether (BLHN) . . . . .	299
3.14	domain BLQT BlowUpWithQuadTrans . . . . .	300
3.14.1	BlowUpWithQuadTrans (BLQT) . . . . .	302
3.15	domain BOOLEAN Boolean . . . . .	303
3.15.1	Boolean (BOOLEAN) . . . . .	304
<b>4</b>	<b>Chapter C</b>	<b>309</b>
4.1	domain CARD CardinalNumber . . . . .	309
4.1.1	CardinalNumber (CARD) . . . . .	316
4.2	domain CARTEN CartesianTensor . . . . .	320
4.2.1	CartesianTensor (CARTEN) . . . . .	340
4.3	domain CHAR Character . . . . .	352
4.3.1	Character (CHAR) . . . . .	357
4.4	domain CCLASS CharacterClass . . . . .	360
4.4.1	CharacterClass (CCLASS) . . . . .	365
4.5	domain CLIF CliffordAlgebra[?, ?] . . . . .	369
4.5.1	Vector (linear) spaces . . . . .	369

4.5.2	Quadratic Forms[?]	370
4.5.3	Quadratic spaces, Clifford Maps[?, ?]	370
4.5.4	Universal Clifford algebras[?]	370
4.5.5	Real Clifford algebras $\mathbb{R}_{p,q}$ [?]	371
4.5.6	Notation for integer sets	371
4.5.7	Frames for Clifford algebras[?, ?, ?]	371
4.5.8	Real frame groups[?, ?]	371
4.5.9	Canonical products[?, ?, ?]	372
4.5.10	Clifford algebra of frame group[?, ?, ?, ?]	372
4.5.11	Neutral matrix representations[?, ?, ?]	373
4.5.12	CliffordAlgebra (CLIF)	386
4.6	domain COLOR Color	390
4.6.1	Color (COLOR)	392
4.7	domain COMM Commutator	394
4.7.1	Commutator (COMM)	395
4.8	domain COMPLEX Complex	397
4.8.1	Complex (COMPLEX)	403
4.9	domain CDFMAT ComplexDoubleFloatMatrix	407
4.9.1	ComplexDoubleFloatMatrix (CDFMAT)	411
4.10	domain CDFVEC ComplexDoubleFloatVector	413
4.10.1	ComplexDoubleFloatVector (CDFVEC)	417
4.11	domain CONTFRAC ContinuedFraction	418
4.11.1	ContinuedFraction (CONTFRAC)	430
<b>5</b>	<b>Chapter D</b>	<b>439</b>
5.1	domain DBASE Database	439
5.1.1	Database (DBASE)	440
5.2	domain DLIST DataList	442
5.2.1	DataList (DLIST)	445
5.3	domain DECIMAL DecimalExpansion	447
5.3.1	DecimalExpansion (DECIMAL)	451
5.4	Denavit-Hartenberg Matrices	453
5.4.1	Homogeneous Transformations	453
5.4.2	Notation	453
5.4.3	Vectors	454
5.4.4	Planes	455
5.4.5	Transformations	457
5.4.6	Translation Transformation	457
5.4.7	Rotation Transformations	459
5.4.8	Coordinate Frames	463
5.4.9	Relative Transformations	463
5.4.10	Objects	464
5.4.11	Inverse Transformations	465
5.4.12	General Rotation Transformation	465
5.4.13	Equivalent Angle and Axis of Rotation	468
5.4.14	Example 1.1	471

5.4.15	Stretching and Scaling . . . . .	472
5.4.16	Perspective Transformations . . . . .	473
5.4.17	Transform Equations . . . . .	475
5.4.18	Summary . . . . .	476
5.4.19	DenavitHartenbergMatrix (DHMATRIX) . . . . .	476
5.5	domain DEQUEUE Dequeue . . . . .	479
5.5.1	Dequeue (DEQUEUE) . . . . .	497
5.6	domain DERHAM DeRhamComplex . . . . .	503
5.6.1	DeRhamComplex (DERHAM) . . . . .	515
5.7	domain DSTREE DesingTree . . . . .	518
5.7.1	DesingTree (DSTREE) . . . . .	520
5.8	domain DSMP DifferentialSparseMultivariatePolynomial . . . . .	522
5.8.1	DifferentialSparseMultivariatePolynomial (DSMP) . . . . .	526
5.9	domain DIRPROD DirectProduct . . . . .	528
5.9.1	DirectProduct (DIRPROD) . . . . .	532
5.10	domain DPMM DirectProductMatrixModule . . . . .	535
5.10.1	DirectProductMatrixModule (DPMM) . . . . .	538
5.11	domain DPMO DirectProductModule . . . . .	539
5.11.1	DirectProductModule (DPMO) . . . . .	542
5.12	domain DIRRING DirichletRing . . . . .	544
5.12.1	DirichletRing (DIRRING) . . . . .	549
5.13	domain DMP DistributedMultivariatePolynomial . . . . .	552
5.13.1	DistributedMultivariatePolynomial (DMP) . . . . .	557
5.14	domain DIV Divisor . . . . .	559
5.14.1	Divisor (DIV) . . . . .	561
5.15	domain DFLOAT DoubleFloat . . . . .	564
5.15.1	DoubleFloat (DFLOAT) . . . . .	572
5.16	domain DFMAT DoubleFloatMatrix . . . . .	580
5.16.1	DoubleFloatMatrix (DFMAT) . . . . .	584
5.17	domain DFVEC DoubleFloatVector . . . . .	586
5.17.1	DoubleFloatVector (DFVEC) . . . . .	590
5.18	domain DROPT DrawOption . . . . .	592
5.18.1	DrawOption (DROPT) . . . . .	593
5.19	domain D01AJFA d01ajfAnnaType . . . . .	598
5.19.1	d01ajfAnnaType (D01AJFA) . . . . .	599
5.20	domain D01AKFA d01akfAnnaType . . . . .	601
5.20.1	d01akfAnnaType (D01AKFA) . . . . .	602
5.21	domain D01ALFA d01alfAnnaType . . . . .	604
5.21.1	d01alfAnnaType (D01ALFA) . . . . .	605
5.22	domain D01AMFA d01amfAnnaType . . . . .	607
5.22.1	d01amfAnnaType (D01AMFA) . . . . .	608
5.23	domain D01ANFA d01anfAnnaType . . . . .	610
5.23.1	d01anfAnnaType (D01ANFA) . . . . .	611
5.24	domain D01APFA d01apfAnnaType . . . . .	613
5.24.1	d01apfAnnaType (D01APFA) . . . . .	614
5.25	domain D01AQFA d01aqfAnnaType . . . . .	616

5.25.1	d01aqfAnnaType (D01AQFA)	618
5.26	domain D01ASFA d01asfAnnaType	620
5.26.1	d01asfAnnaType (D01ASFA)	621
5.27	domain D01FCFA d01fcfAnnaType	623
5.27.1	d01fcfAnnaType (D01FCFA)	624
5.28	domain D01GBFA d01gbfAnnaType	626
5.28.1	d01gbfAnnaType (D01GBFA)	627
5.29	domain D01TRNS d01TransformFunctionType	629
5.29.1	d01TransformFunctionType (D01TRNS)	630
5.30	domain D02BBFA d02bbfAnnaType	634
5.30.1	d02bbfAnnaType (D02BBFA)	635
5.31	domain D02BHFA d02bhfAnnaType	637
5.31.1	d02bhfAnnaType (D02BHFA)	638
5.32	domain D02CJFA d02cjfAnnaType	641
5.32.1	d02cjfAnnaType (D02CJFA)	642
5.33	domain D02EJFA d02ejfAnnaType	644
5.33.1	d02ejfAnnaType (D02EJFA)	645
5.34	domain D03EEFA d03eefAnnaType	648
5.34.1	d03eefAnnaType (D03EEFA)	649
5.35	domain D03FAFA d03fafAnnaType	651
5.35.1	d03fafAnnaType (D03FAFA)	652
<b>6</b>	<b>Chapter E</b>	<b>655</b>
6.1	domain EQ Equation	655
6.1.1	Equation (EQ)	659
6.2	domain EQTBL EqTable	664
6.2.1	EqTable (EQTBL)	667
6.3	domain EMR EuclideanModularRing	668
6.3.1	EuclideanModularRing (EMR)	670
6.4	domain EXIT Exit	673
6.4.1	Exit (EXIT)	675
6.5	domain EXPEXPAN ExponentialExpansion	676
6.5.1	ExponentialExpansion (EXPEXPAN)	679
6.6	domain EXPR Expression	683
6.6.1	Expression (EXPR)	691
6.7	domain EXPUPXS ExponentialOfUnivariatePuisseuxSeries	703
6.7.1	ExponentialOfUnivariatePuisseuxSeries (EXPUPXS)	707
6.8	domain EAB ExtAlgBasis	710
6.8.1	ExtAlgBasis (EAB)	711
6.9	domain E04DGFA e04dgmAnnaType	713
6.9.1	e04dgmAnnaType (E04DGFA)	714
6.10	domain E04FDFA e04fdfAnnaType	716
6.10.1	e04fdfAnnaType (E04FDFA)	718
6.11	domain E04GCFA e04gcfAnnaType	720
6.11.1	e04gcfAnnaType (E04GCFA)	721
6.12	domain E04JAFA e04jafAnnaType	724

6.12.1	e04jafAnnaType (E04JAFA)	726
6.13	domain E04MBFA e04mbfAnnaType	728
6.13.1	e04mbfAnnaType (E04MBFA)	729
6.14	domain E04NAFA e04nafAnnaType	731
6.14.1	e04nafAnnaType (E04NAFA)	733
6.15	domain E04UCFA e04ucfAnnaType	735
6.15.1	e04ucfAnnaType (E04UCFA)	736
<b>7</b>	<b>Chapter F</b>	<b>741</b>
7.1	domain FR Factored	741
7.1.1	Factored (FR)	754
7.2	domain FILE File	765
7.2.1	File (FILE)	770
7.3	domain FNAME FileName	772
7.3.1	FileName (FNAME)	778
7.4	domain FDIV FiniteDivisor	779
7.4.1	FiniteDivisor (FDIV)	781
7.5	domain FF FiniteField	784
7.5.1	FiniteField (FF)	787
7.6	domain FFCG FiniteFieldCyclicGroup	789
7.6.1	FiniteFieldCyclicGroup (FFCG)	792
7.7	domain FFCGX FiniteFieldCyclicGroupExtension	794
7.7.1	FiniteFieldCyclicGroupExtension (FFCGX)	797
7.8	domain FFCGP FiniteFieldCyclicGroupExtensionByPolynomial	799
7.8.1	FiniteFieldCyclicGroupExtensionByPolynomial (FFCGP)	802
7.9	domain FFX FiniteFieldExtension	810
7.9.1	FiniteFieldExtension (FFX)	813
7.10	domain FFP FiniteFieldExtensionByPolynomial	815
7.10.1	FiniteFieldExtensionByPolynomial (FFP)	818
7.11	domain FFNB FiniteFieldNormalBasis	824
7.11.1	FiniteFieldNormalBasis (FFNB)	827
7.12	domain FFNBX FiniteFieldNormalBasisExtension	830
7.12.1	FiniteFieldNormalBasisExtension (FFNBX)	832
7.13	domain FFNBP FiniteFieldNormalBasisExtensionByPolynomial	835
7.13.1	FiniteFieldNormalBasisExtensionByPolynomial (FFNBP)	838
7.14	domain FARRAY FlexibleArray	847
7.14.1	FlexibleArray (FARRAY)	853
7.15	domain FLOAT Float	854
7.15.1	Float (FLOAT)	875
7.16	domain FC FortranCode	896
7.16.1	FortranCode (FC)	898
7.17	domain FEXPR FortranExpression	911
7.17.1	FortranExpression (FEXPR)	914
7.18	domain FORTRAN FortranProgram	922
7.18.1	FortranProgram (FORTRAN)	923
7.19	domain FST FortranScalarType	928

7.19.1	FortranScalarType (FST)	929
7.20	domain FTEM FortranTemplate	933
7.20.1	FortranTemplate (FTEM)	934
7.21	domain FT FortranType	937
7.21.1	FortranType (FT)	938
7.22	domain FCOMP FourierComponent	941
7.22.1	FourierComponent (FCOMP)	942
7.23	domain FSERIES FourierSeries	943
7.23.1	FourierSeries (FSERIES)	945
7.24	domain FRAC Fraction	947
7.24.1	Fraction (FRAC)	952
7.25	domain FRIDEAL FractionalIdeal	960
7.25.1	FractionalIdeal (FRIDEAL)	961
7.26	domain FRMOD FramedModule	965
7.26.1	FramedModule (FRMOD)	967
7.27	domain FAGROUP FreeAbelianGroup	969
7.27.1	FreeAbelianGroup (FAGROUP)	971
7.28	domain FAMONOID FreeAbelianMonoid	973
7.28.1	FreeAbelianMonoid (FAMONOID)	974
7.29	domain FGROUPO FreeGroup	975
7.29.1	FreeGroup (FGROUP)	976
7.30	domain FM FreeModule	978
7.30.1	FreeModule (FM)	980
7.31	domain FM1 FreeModule1	982
7.31.1	FreeModule1 (FM1)	983
7.32	domain FMONOID FreeMonoid	986
7.32.1	FreeMonoid (FMONOID)	987
7.33	domain FNLA FreeNilpotentLie	992
7.33.1	FreeNilpotentLie (FNLA)	993
7.34	domain FPARFRAC FullPartialFractionExpansion	996
7.34.1	FullPartialFractionExpansion (FPARFRAC)	1006
7.35	domain FUNCTION FunctionCalled	1010
7.35.1	FunctionCalled (FUNCTION)	1011
<b>8</b>	<b>Chapter G</b>	<b>1013</b>
8.1	domain GDMP GeneralDistributedMultivariatePolynomial	1013
8.1.1	GeneralDistributedMultivariatePolynomial (GDMP)	1018
8.2	domain GMODPOL GeneralModulePolynomial	1024
8.2.1	GeneralModulePolynomial (GMODPOL)	1025
8.3	domain GCNAALG GenericNonAssociativeAlgebra	1027
8.3.1	GenericNonAssociativeAlgebra (GCNAALG)	1030
8.4	domain GPOLSET GeneralPolynomialSet	1038
8.4.1	GeneralPolynomialSet (GPOLSET)	1040
8.5	domain GSTBL GeneralSparseTable	1042
8.5.1	GeneralSparseTable (GSTBL)	1044
8.6	domain GTSET GeneralTriangularSet	1046



8.6.1	GeneralTriangularSet (GTSET)	1049
8.7	domain GSERIES GeneralUnivariatePowerSeries	1053
8.7.1	GeneralUnivariatePowerSeries (GSERIES)	1056
8.8	domain GRIMAGE GraphImage	1060
8.8.1	GraphImage (GRIMAGE)	1061
8.9	domain GOPT GuessOption	1070
8.9.1	GuessOption (GOPT)	1071
8.10	domain GOPT0 GuessOptionFunctions0	1075
8.10.1	GuessOptionFunctions0 (GOPT0)	1076
<b>9</b>	<b>Chapter H</b>	<b>1083</b>
9.1	domain HASHTBL HashTable	1083
9.1.1	HashTable (HASHTBL)	1085
9.2	domain HEAP Heap	1087
9.2.1	Heap (HEAP)	1100
9.3	domain HEXADEC HexadecimalExpansion	1105
9.3.1	HexadecimalExpansion (HEXADEC)	1108
9.4	package HTMLFORM HTMLFormat	1110
9.4.1	Overview	1111
9.4.2	Why output to HTML?	1111
9.5	Using the formatter	1111
9.6	Form of the output	1112
9.7	Matrix Formatting	1112
9.8	Programmers Guide	1113
9.8.1	Future Developments	1113
9.8.2	HTMLFormat (HTMLFORM)	1118
9.9	domain HDP HomogeneousDirectProduct	1135
9.9.1	HomogeneousDirectProduct (HDP)	1138
9.10	domain HDMP HomogeneousDistributedMultivariatePolynomial	1140
9.10.1	HomogeneousDistributedMultivariatePolynomial (HDMP)	1145
9.11	domain HELLFDIV HyperellipticFiniteDivisor	1147
9.11.1	HyperellipticFiniteDivisor (HELLFDIV)	1149
<b>10</b>	<b>Chapter I</b>	<b>1155</b>
10.1	domain ICP InfClsPt	1155
10.1.1	InfClsPt (ICP)	1156
10.2	domain ICARD IndexCard	1158
10.2.1	IndexCard (ICARD)	1159
10.3	domain IBITS IndexedBits	1161
10.3.1	IndexedBits (IBITS)	1165
10.4	domain IDPAG IndexedDirectProductAbelianGroup	1167
10.4.1	IndexedDirectProductAbelianGroup (IDPAG)	1168
10.5	domain IDPAM IndexedDirectProductAbelianMonoid	1170
10.5.1	IndexedDirectProductAbelianMonoid (IDPAM)	1171
10.6	domain IDPO IndexedDirectProductObject	1174
10.6.1	IndexedDirectProductObject (IDPO)	1175

10.7 domain IDPOAM IndexedDirectProductOrderedAbelianMonoid . . . . .	1176
10.7.1 IndexedDirectProductOrderedAbelianMonoid (IDPOAM) . . . . .	1178
10.8 domain IDPOAMS IndexedDirectProductOrderedAbelianMonoidSup . . . . .	1179
10.8.1 IndexedDirectProductOrderedAbelianMonoidSup (IDPOAMS) . . . . .	1180
10.9 domain INDE IndexedExponents . . . . .	1182
10.9.1 IndexedExponents (INDE) . . . . .	1183
10.10domain IFARRAY IndexedFlexibleArray . . . . .	1184
10.10.1 IndexedFlexibleArray (IFARRAY) . . . . .	1187
10.11domain ILIST IndexedList . . . . .	1193
10.11.1 IndexedList (ILIST) . . . . .	1196
10.12domain IMATRIX IndexedMatrix . . . . .	1201
10.12.1 IndexedMatrix (IMATRIX) . . . . .	1204
10.13domain IARRAY1 IndexedOneDimensionalArray . . . . .	1206
10.13.1 IndexedOneDimensionalArray (IARRAY1) . . . . .	1208
10.14domain ISTRING IndexedString . . . . .	1211
10.14.1 IndexedString (ISTRING) . . . . .	1214
10.15domain IARRAY2 IndexedTwoDimensionalArray . . . . .	1219
10.15.1 IndexedTwoDimensionalArray (IARRAY2) . . . . .	1221
10.16domain IVECTOR IndexedVector . . . . .	1222
10.16.1 IndexedVector (IVECTOR) . . . . .	1225
10.17domain ITUPLE InfiniteTuple . . . . .	1226
10.17.1 InfiniteTuple (ITUPLE) . . . . .	1227
10.18domain INFCLSPT InfinitelyClosePoint . . . . .	1228
10.18.1 InfinitelyClosePoint (INFCLSPT) . . . . .	1230
10.19domain INFCLSPS InfinitelyClosePointOverPseudoAlgebraicClosureOfFinite- Field . . . . .	1234
10.19.1 InfinitelyClosePointOverPseudoAlgebraicClosureOfFiniteField (INFCLSPS)	1235
10.20domain IAN InnerAlgebraicNumber . . . . .	1237
10.20.1 InnerAlgebraicNumber (IAN) . . . . .	1240
10.21domain IFF InnerFiniteField . . . . .	1244
10.21.1 InnerFiniteField (IFF) . . . . .	1247
10.22domain IFAMON InnerFreeAbelianMonoid . . . . .	1249
10.22.1 InnerFreeAbelianMonoid (IFAMON) . . . . .	1250
10.23domain IIARRAY2 InnerIndexedTwoDimensionalArray . . . . .	1252
10.23.1 InnerIndexedTwoDimensionalArray (IIARRAY2) . . . . .	1254
10.24domain IPADIC InnerPAdicInteger . . . . .	1256
10.24.1 InnerPAdicInteger (IPADIC) . . . . .	1258
10.25domain IPF InnerPrimeField . . . . .	1264
10.25.1 InnerPrimeField (IPF) . . . . .	1267
10.26domain ISUPS InnerSparseUnivariatePowerSeries . . . . .	1271
10.26.1 InnerSparseUnivariatePowerSeries (ISUPS) . . . . .	1274
10.27domain INTABL InnerTable . . . . .	1297
10.27.1 InnerTable (INTABL) . . . . .	1299
10.28domain ITAYLOR InnerTaylorSeries . . . . .	1301
10.28.1 InnerTaylorSeries (ITAYLOR) . . . . .	1302
10.29domain INFORM InputForm . . . . .	1305

10.29.1 InputForm (INFORM) . . . . .	1307
10.30 domain INT Integer . . . . .	1311
10.30.1 Integer (INT) . . . . .	1325
10.31 domain ZMOD IntegerMod . . . . .	1330
10.31.1 IntegerMod (ZMOD) . . . . .	1331
10.32 domain INTFTBL IntegrationFunctionsTable . . . . .	1334
10.32.1 IntegrationFunctionsTable (INTFTBL) . . . . .	1335
10.33 domain IR IntegrationResult . . . . .	1337
10.33.1 IntegrationResult (IR) . . . . .	1339
10.34 domain INTRVL Interval . . . . .	1343
10.34.1 Interval (INTRVL) . . . . .	1348
<b>11 Chapter J</b>	<b>1359</b>
<b>12 Chapter K</b>	<b>1361</b>
12.1 domain KERNEL Kernel . . . . .	1361
12.1.1 Kernel (KERNEL) . . . . .	1368
12.2 domain KAFILE KeyedAccessFile . . . . .	1371
12.2.1 KeyedAccessFile (KAFILE) . . . . .	1377
<b>13 Chapter L</b>	<b>1383</b>
13.1 domain LAUPOL LaurentPolynomial . . . . .	1383
13.1.1 LaurentPolynomial (LAUPOL) . . . . .	1385
13.2 domain LIB Library . . . . .	1389
13.2.1 Library (LIB) . . . . .	1392
13.3 domain LEXP LieExponentials . . . . .	1394
13.3.1 LieExponentials (LEXP) . . . . .	1399
13.4 domain LPOLY LiePolynomial . . . . .	1402
13.4.1 LiePolynomial (LPOLY) . . . . .	1410
13.5 domain LSQM LieSquareMatrix . . . . .	1415
13.5.1 LieSquareMatrix (LSQM) . . . . .	1419
13.6 domain LODO LinearOrdinaryDifferentialOperator . . . . .	1423
13.6.1 LinearOrdinaryDifferentialOperator (LODO) . . . . .	1433
13.7 domain LODO1 LinearOrdinaryDifferentialOperator1 . . . . .	1434
13.7.1 LinearOrdinaryDifferentialOperator1 (LODO1) . . . . .	1443
13.8 domain LODO2 LinearOrdinaryDifferentialOperator2 . . . . .	1444
13.8.1 LinearOrdinaryDifferentialOperator2 (LODO2) . . . . .	1455
13.9 domain LIST List . . . . .	1456
13.9.1 List (LIST) . . . . .	1468
13.10 domain LMOPS ListMonoidOps . . . . .	1471
13.10.1 ListMonoidOps (LMOPS) . . . . .	1473
13.11 domain LMDICT ListMultiDictionary . . . . .	1477
13.11.1 ListMultiDictionary (LMDICT) . . . . .	1478
13.12 domain LA LocalAlgebra . . . . .	1482
13.12.1 LocalAlgebra (LA) . . . . .	1484
13.13 domain LO Localize . . . . .	1485

13.13.1	Localize (LO)	1486
13.14	domain LWORD LyndonWord	1488
13.14.1	LyndonWord (LWORD)	1496
<b>14</b>	<b>Chapter M</b>	<b>1501</b>
14.1	domain MCMPLX MachineComplex	1501
14.1.1	MachineComplex (MCMPLX)	1506
14.2	domain MFLOAT MachineFloat	1509
14.2.1	MachineFloat (MFLOAT)	1511
14.3	domain MINT MachineInteger	1518
14.3.1	MachineInteger (MINT)	1521
14.4	domain MAGMA Magma	1523
14.4.1	Magma (MAGMA)	1529
14.5	domain MKCHSET MakeCachableSet	1533
14.5.1	MakeCachableSet (MKCHSET)	1534
14.6	domain MMLFORM MathMLFormat	1535
14.6.1	Introduction to Mathematical Markup Language	1536
14.6.2	Displaying MathML	1536
14.6.3	Test Cases	1537
14.6.4	)set output mathml on	1538
14.6.5	File src/interp/setvars.boot.pamphlet	1538
14.6.6	File setvart.boot.pamphlet	1538
14.6.7	File src/algebra/Makefile.pamphlet	1539
14.6.8	File src/algebra/exposed.lsp.pamphlet	1539
14.6.9	File src/algebra/Lattice.pamphlet	1539
14.6.10	File src/doc/axiom.bib.pamphlet	1540
14.6.11	File interp/i-output.boot.pamphlet	1540
14.6.12	Public Declarations	1540
14.6.13	Private Constant Declarations	1542
14.6.14	Private Function Declarations	1543
14.6.15	Public Function Definitions	1545
14.6.16	Private Function Definitions	1547
14.6.17	Mathematical Markup Language Form	1563
14.6.18	MathMLForm (MMLFORM)	1567
14.7	domain MATRIX Matrix	1568
14.7.1	Matrix (MATRIX)	1586
14.8	domain MODMON ModMonic	1591
14.8.1	ModMonic (MODMON)	1595
14.9	domain MODFIELD ModularField	1600
14.9.1	ModularField (MODFIELD)	1602
14.10	domain MODRING ModularRing	1603
14.10.1	ModularRing (MODRING)	1604
14.11	domain MODMONOM ModuleMonomial	1607
14.11.1	ModuleMonomial (MODMONOM)	1608
14.12	domain MODOP ModuleOperator	1609
14.12.1	ModuleOperator (MODOP)	1611

14.13domain MOEBIUS MoebiusTransform . . . . .	1616
14.13.1 MoebiusTransform (MOEBIUS) . . . . .	1617
14.14domain MRING MonoidRing . . . . .	1620
14.14.1 MonoidRing (MRING) . . . . .	1622
14.15domain MSET Multiset . . . . .	1629
14.15.1 Multiset (MSET) . . . . .	1634
14.16domain MPOLY MultivariatePolynomial . . . . .	1640
14.16.1 MultivariatePolynomial (MPOLY) . . . . .	1645
14.17domain MYEXPR MyExpression . . . . .	1647
14.17.1 MyExpression (MYEXPR) . . . . .	1651
14.18domain MYUP MyUnivariatePolynomial . . . . .	1653
14.18.1 MyUnivariatePolynomial (MYUP) . . . . .	1658
<b>15 Chapter N</b>	<b>1661</b>
15.1 domain NSDPS NeitherSparseOrDensePowerSeries . . . . .	1661
15.1.1 NeitherSparseOrDensePowerSeries (NSDPS) . . . . .	1665
15.2 domain NSMP NewSparseMultivariatePolynomial . . . . .	1672
15.2.1 NewSparseMultivariatePolynomial (NSMP) . . . . .	1676
15.3 domain NSUP NewSparseUnivariatePolynomial . . . . .	1686
15.3.1 NewSparseUnivariatePolynomial (NSUP) . . . . .	1691
15.4 domain NONE None . . . . .	1698
15.4.1 None (NONE) . . . . .	1700
15.5 domain NNI NonNegativeInteger . . . . .	1701
15.5.1 NonNegativeInteger (NNI) . . . . .	1702
15.6 domain NOTTING NottinghamGroup . . . . .	1704
15.6.1 NottinghamGroup (NOTTING) . . . . .	1707
15.7 domain NIPROB NumericalIntegrationProblem . . . . .	1708
15.7.1 NumericalIntegrationProblem (NIPROB) . . . . .	1709
15.8 domain ODEPROB NumericalODEProblem . . . . .	1711
15.8.1 NumericalODEProblem (ODEPROB) . . . . .	1712
15.9 domain OPTPROB NumericalOptimizationProblem . . . . .	1714
15.9.1 NumericalOptimizationProblem (OPTPROB) . . . . .	1715
15.10domain PDEPROB NumericalPDEProblem . . . . .	1717
15.10.1 NumericalPDEProblem (PDEPROB) . . . . .	1718
<b>16 Chapter O</b>	<b>1721</b>
16.1 domain OCT Octonion . . . . .	1721
16.1.1 Octonion (OCT) . . . . .	1727
16.2 domain ODEIFTBL ODEIntensityFunctionsTable . . . . .	1729
16.2.1 ODEIntensityFunctionsTable (ODEIFTBL) . . . . .	1730
16.3 domain ARRAY1 OneDimensionalArray . . . . .	1732
16.3.1 OneDimensionalArray (ARRAY1) . . . . .	1736
16.4 domain ONECOMP OnePointCompletion . . . . .	1737
16.4.1 OnePointCompletion (ONECOMP) . . . . .	1739
16.5 domain OMCONN OpenMathConnection . . . . .	1742
16.5.1 OpenMathConnection (OMCONN) . . . . .	1743

16.6 domain OMDEV OpenMathDevice . . . . .	1744
16.6.1 OpenMathDevice (OMDEV) . . . . .	1746
16.7 domain OMENC OpenMathEncoding . . . . .	1750
16.7.1 OpenMathEncoding (OMENC) . . . . .	1751
16.8 domain OMERR OpenMathError . . . . .	1753
16.8.1 OpenMathError (OMERR) . . . . .	1754
16.9 domain OMERRK OpenMathErrorKind . . . . .	1755
16.9.1 OpenMathErrorKind (OMERRK) . . . . .	1756
16.10 domain OP Operator . . . . .	1758
16.10.1 Operator (OP) . . . . .	1766
16.11 domain OMLO OppositeMonogenicLinearOperator . . . . .	1767
16.11.1 OppositeMonogenicLinearOperator (OMLO) . . . . .	1768
16.12 domain ORDCOMP OrderedCompletion . . . . .	1770
16.12.1 OrderedCompletion (ORDCOMP) . . . . .	1772
16.13 domain ODP OrderedDirectProduct . . . . .	1775
16.13.1 OrderedDirectProduct (ODP) . . . . .	1778
16.14 domain OFMONOID OrderedFreeMonoid . . . . .	1780
16.14.1 OrderedFreeMonoid (OFMONOID) . . . . .	1791
16.15 domain OVAR OrderedVariableList . . . . .	1796
16.15.1 OrderedVariableList (OVAR) . . . . .	1798
16.16 domain ODPOL OrderlyDifferentialPolynomial . . . . .	1799
16.16.1 OrderlyDifferentialPolynomial (ODPOL) . . . . .	1813
16.17 domain ODVAR OrderlyDifferentialVariable . . . . .	1815
16.17.1 OrderlyDifferentialVariable (ODVAR) . . . . .	1816
16.18 domain ODR OrdinaryDifferentialRing . . . . .	1818
16.18.1 OrdinaryDifferentialRing (ODR) . . . . .	1820
16.19 domain OWP OrdinaryWeightedPolynomials . . . . .	1821
16.19.1 OrdinaryWeightedPolynomials (OWP) . . . . .	1823
16.20 domain OSI OrdSetInts . . . . .	1824
16.20.1 OrdSetInts (OSI) . . . . .	1825
16.21 domain OUTFORM OutputForm . . . . .	1827
16.21.1 OutputForm (OUTFORM) . . . . .	1829
<b>17 Chapter P</b>	<b>1839</b>
17.1 domain PADIC PAdicInteger . . . . .	1839
17.1.1 PAdicInteger (PADIC) . . . . .	1841
17.2 domain PADICRAT PAdicRational . . . . .	1842
17.2.1 PAdicRational (PADICRAT) . . . . .	1845
17.3 domain PADICRC PAdicRationalConstructor . . . . .	1847
17.3.1 PAdicRationalConstructor (PADICRC) . . . . .	1850
17.4 domain PALETTE Palette . . . . .	1855
17.4.1 Palette (PALETTE) . . . . .	1856
17.5 domain PARPCURV ParametricPlaneCurve . . . . .	1858
17.5.1 ParametricPlaneCurve (PARPCURV) . . . . .	1859
17.6 domain PARSCURV ParametricSpaceCurve . . . . .	1860
17.6.1 ParametricSpaceCurve (PARSCURV) . . . . .	1861

17.7 domain PARSURF ParametricSurface . . . . .	1863
17.7.1 ParametricSurface (PARSURF) . . . . .	1864
17.8 domain PFR PartialFraction . . . . .	1865
17.8.1 PartialFraction (PFR) . . . . .	1873
17.9 domain PRTITION Partition . . . . .	1881
17.9.1 Partition (PRTITION) . . . . .	1883
17.10domain PATTERN Pattern . . . . .	1886
17.10.1 Pattern (PATTERN) . . . . .	1888
17.11domain PATLRES PatternMatchListResult . . . . .	1896
17.11.1 PatternMatchListResult (PATLRES) . . . . .	1897
17.12domain PATRES PatternMatchResult . . . . .	1899
17.12.1 PatternMatchResult (PATRES) . . . . .	1900
17.13domain PENDTREE PendantTree . . . . .	1902
17.13.1 PendantTree (PENDTREE) . . . . .	1904
17.14domain PERM Permutation . . . . .	1906
17.14.1 Permutation (PERM) . . . . .	1909
17.15domain PERMGRP PermutationGroup . . . . .	1917
17.15.1 PermutationGroup (PERMGRP) . . . . .	1919
17.16domain HACKPI Pi . . . . .	1935
17.16.1 Pi (HACKPI) . . . . .	1937
17.17domain ACPLOT PlaneAlgebraicCurvePlot . . . . .	1939
17.17.1 PlaneAlgebraicCurvePlot (ACPLOT) . . . . .	1952
17.18domain PLACES Places . . . . .	1977
17.18.1 Places (PLACES) . . . . .	1978
17.19domain PLACESPS PlacesOverPseudoAlgebraicClosureOfFiniteField . . . . .	1979
17.19.1 PlacesOverPseudoAlgebraicClosureOfFiniteField (PLACESPS) . . . . .	1980
17.20domain PLCS Plcs . . . . .	1981
17.20.1 Plcs (PLCS) . . . . .	1983
17.21domain PLOT Plot . . . . .	1986
17.21.1 Plot (PLOT) . . . . .	1988
17.22domain PLOT3D Plot3D . . . . .	2000
17.22.1 Plot3D (PLOT3D) . . . . .	2002
17.23domain PBWLB PoincareBirkhoffWittLyndonBasis . . . . .	2012
17.23.1 PoincareBirkhoffWittLyndonBasis (PBWLB) . . . . .	2013
17.24domain POINT Point . . . . .	2016
17.24.1 Point (POINT) . . . . .	2019
17.25domain POLY Polynomial . . . . .	2020
17.25.1 Polynomial (POLY) . . . . .	2037
17.26domain IDEAL PolynomialIdeals . . . . .	2039
17.26.1 PolynomialIdeals (IDEAL) . . . . .	2041
17.27domain PR PolynomialRing . . . . .	2050
17.27.1 PolynomialRing (PR) . . . . .	2052
17.28domain PI PositiveInteger . . . . .	2059
17.28.1 PositiveInteger (PI) . . . . .	2060
17.29domain PF PrimeField . . . . .	2061
17.29.1 PrimeField (PF) . . . . .	2064

17.30domain PRIMARR PrimitiveArray . . . . .	2066
17.30.1 PrimitiveArray (PRIMARR) . . . . .	2069
17.31domain PRODUCT Product . . . . .	2070
17.31.1 Product (PRODUCT) . . . . .	2072
17.32domain PROJPL ProjectivePlane . . . . .	2075
17.32.1 ProjectivePlane (PROJPL) . . . . .	2076
17.33domain PROJPLPS ProjectivePlaneOverPseudoAlgebraicClosureOfFiniteField	2077
17.33.1 ProjectivePlaneOverPseudoAlgebraicClosureOfFiniteField (PROJPLPS)	2079
17.34domain PROJSP ProjectiveSpace . . . . .	2080
17.34.1 ProjectiveSpace (PROJSP) . . . . .	2081
17.35domain PACEXT PseudoAlgebraicClosureOfAlgExtOfRationalNumber . . .	2084
17.35.1 PseudoAlgebraicClosureOfAlgExtOfRationalNumber (PACEXT) . . .	2085
17.36domain PACOFF PseudoAlgebraicClosureOfFiniteField . . . . .	2092
17.36.1 PseudoAlgebraicClosureOfFiniteField (PACOFF) . . . . .	2094
17.37domain PACRAT PseudoAlgebraicClosureOfRationalNumber . . . . .	2102
17.37.1 PseudoAlgebraicClosureOfRationalNumber (PACRAT) . . . . .	2105
<b>18 Chapter Q</b>	<b>2113</b>
18.1 domain QFORM QuadraticForm . . . . .	2113
18.1.1 QuadraticForm (QFORM) . . . . .	2114
18.2 domain QALGSET QuasiAlgebraicSet . . . . .	2116
18.2.1 QuasiAlgebraicSet (QALGSET) . . . . .	2117
18.3 domain QUAT Quaternion . . . . .	2121
18.3.1 Quaternion (QUAT) . . . . .	2126
18.4 domain QEQUAT QueryEquation . . . . .	2128
18.4.1 QueryEquation (QEQUAT) . . . . .	2129
18.5 domain QUEUE Queue . . . . .	2130
18.5.1 Queue (QUEUE) . . . . .	2143
<b>19 Chapter R</b>	<b>2149</b>
19.1 domain RADFF RadicalFunctionField . . . . .	2149
19.1.1 RadicalFunctionField (RADFF) . . . . .	2153
19.2 domain RADIX RadixExpansion . . . . .	2159
19.2.1 RadixExpansion (RADIX) . . . . .	2165
19.3 domain RECLOS RealClosure . . . . .	2171
19.3.1 RealClosure (RECLOS) . . . . .	2196
19.4 domain RMATRIX RectangularMatrix . . . . .	2203
19.4.1 RectangularMatrix (RMATRIX) . . . . .	2205
19.5 domain REF Reference . . . . .	2208
19.5.1 Reference (REF) . . . . .	2209
19.6 domain RGCHAIN RegularChain . . . . .	2211
19.6.1 RegularChain (RGCHAIN) . . . . .	2214
19.7 domain REGSET RegularTriangularSet . . . . .	2217
19.7.1 RegularTriangularSet (REGSET) . . . . .	2245
19.8 domain RESRING ResidueRing . . . . .	2255
19.8.1 ResidueRing (RESRING) . . . . .	2256



19.9 domain RESULT Result . . . . .	2258
19.9.1 Result (RESULT) . . . . .	2260
19.10domain RULE RewriteRule . . . . .	2263
19.10.1 RewriteRule (RULE) . . . . .	2265
19.11domain ROIRC RightOpenIntervalRootCharacterization . . . . .	2268
19.11.1 RightOpenIntervalRootCharacterization (ROIRC) . . . . .	2270
19.12domain ROMAN RomanNumeral . . . . .	2280
19.12.1 RomanNumeral (ROMAN) . . . . .	2286
19.13domain ROUTINE RoutinesTable . . . . .	2288
19.13.1 RoutinesTable (ROUTINE) . . . . .	2291
19.14domain RULECOLD RuleCalled . . . . .	2300
19.14.1 RuleCalled (RULECOLD) . . . . .	2301
19.15domain RULESET Ruleset . . . . .	2302
19.15.1 Ruleset (RULESET) . . . . .	2303

**20 Chapter S****2305**

20.1 domain FORMULA ScriptFormulaFormat . . . . .	2305
20.1.1 ScriptFormulaFormat (FORMULA) . . . . .	2306
20.2 domain SEG Segment . . . . .	2315
20.2.1 Segment (SEG) . . . . .	2319
20.3 domain SEGBIND SegmentBinding . . . . .	2321
20.3.1 SegmentBinding (SEGBIND) . . . . .	2324
20.4 domain SET Set . . . . .	2325
20.4.1 Set (SET) . . . . .	2332
20.5 domain SETMN SetOfMIntegersInOneToN . . . . .	2336
20.5.1 SetOfMIntegersInOneToN (SETMN) . . . . .	2337
20.6 domain SDPOL SequentialDifferentialPolynomial . . . . .	2341
20.6.1 SequentialDifferentialPolynomial (SDPOL) . . . . .	2345
20.7 domain SDVAR SequentialDifferentialVariable . . . . .	2347
20.7.1 SequentialDifferentialVariable (SDVAR) . . . . .	2348
20.8 domain SEX SExpression . . . . .	2350
20.8.1 SExpression (SEX) . . . . .	2351
20.9 domain SEXOF SExpressionOf . . . . .	2352
20.9.1 SExpressionOf (SEXOF) . . . . .	2353
20.10domain SAE SimpleAlgebraicExtension . . . . .	2355
20.10.1 SimpleAlgebraicExtension (SAE) . . . . .	2359
20.11domain SFORT SimpleFortranProgram . . . . .	2363
20.11.1 SimpleFortranProgram (SFORT) . . . . .	2364
20.12domain SINT SingleInteger . . . . .	2366
20.12.1 SingleInteger (SINT) . . . . .	2371
20.13domain SAOS SingletonAsOrderedSet . . . . .	2376
20.13.1 SingletonAsOrderedSet (SAOS) . . . . .	2377
20.14domain SMP SparseMultivariatePolynomial . . . . .	2378
20.14.1 SparseMultivariatePolynomial (SMP) . . . . .	2381
20.15domain SMTS SparseMultivariateTaylorSeries . . . . .	2394
20.15.1 SparseMultivariateTaylorSeries (SMTS) . . . . .	2399

20.16domain STBL SparseTable . . . . .	2406
20.16.1 SparseTable (STBL) . . . . .	2409
20.17domain SULS SparseUnivariateLaurentSeries . . . . .	2410
20.17.1 SparseUnivariateLaurentSeries (SULS) . . . . .	2415
20.18domain SUP SparseUnivariatePolynomial . . . . .	2421
20.18.1 SparseUnivariatePolynomial (SUP) . . . . .	2425
20.19domain SUEXPR SparseUnivariatePolynomialExpressions . . . . .	2434
20.19.1 SparseUnivariatePolynomialExpressions (SUEXPR) . . . . .	2439
20.20domain SUPXS SparseUnivariatePuisseuxSeries . . . . .	2442
20.20.1 SparseUnivariatePuisseuxSeries (SUPXS) . . . . .	2445
20.21domain ORESUP SparseUnivariateSkewPolynomial . . . . .	2448
20.21.1 SparseUnivariateSkewPolynomial (ORESUP) . . . . .	2450
20.22domain SUTS SparseUnivariateTaylorSeries . . . . .	2452
20.22.1 SparseUnivariateTaylorSeries (SUTS) . . . . .	2455
20.23domain SHDP SplitHomogeneousDirectProduct . . . . .	2463
20.23.1 SplitHomogeneousDirectProduct (SHDP) . . . . .	2467
20.24domain SPLNODE SplittingNode . . . . .	2469
20.24.1 SplittingNode (SPLNODE) . . . . .	2470
20.25domain SPLTREE SplittingTree . . . . .	2474
20.25.1 SplittingTree (SPLTREE) . . . . .	2476
20.26domain SREGSET SquareFreeRegularTriangularSet . . . . .	2483
20.26.1 SquareFreeRegularTriangularSet (SREGSET) . . . . .	2492
20.27domain SQMATRIX SquareMatrix . . . . .	2502
20.27.1 SquareMatrix (SQMATRIX) . . . . .	2505
20.28domain STACK Stack . . . . .	2509
20.28.1 Stack (STACK) . . . . .	2521
20.29domain SD StochasticDifferential . . . . .	2526
20.29.1 StochasticDifferential (SD) . . . . .	2530
20.30domain STREAM Stream . . . . .	2536
20.30.1 Stream (STREAM) . . . . .	2540
20.31domain STRING String . . . . .	2555
20.31.1 String (STRING) . . . . .	2565
20.32domain STRTBL StringTable . . . . .	2567
20.32.1 StringTable (STRTBL) . . . . .	2569
20.33domain SUBSPACE SubSpace . . . . .	2570
20.33.1 SubSpace (SUBSPACE) . . . . .	2573
20.34domain COMPPROP SubSpaceComponentProperty . . . . .	2582
20.34.1 SubSpaceComponentProperty (COMPPROP) . . . . .	2583
20.35domain SUCH SuchThat . . . . .	2584
20.35.1 SuchThat (SUCH) . . . . .	2586
20.36domain SWITCH Switch . . . . .	2587
20.36.1 Switch (SWITCH) . . . . .	2588
20.37domain SYMBOL Symbol . . . . .	2590
20.37.1 Symbol (SYMBOL) . . . . .	2598
20.38domain SYMTAB SymbolTable . . . . .	2605
20.38.1 SymbolTable (SYMTAB) . . . . .	2606

20.39domain SYMPOLY SymmetricPolynomial . . . . .	2611
20.39.1 SymmetricPolynomial (SYMPOLY) . . . . .	2613
<b>21 Chapter T</b>	<b>2615</b>
21.1 domain TABLE Table . . . . .	2615
21.1.1 Table (TABLE) . . . . .	2621
21.2 domain TABLEAU Tableau . . . . .	2623
21.2.1 Tableau (TABLEAU) . . . . .	2624
21.3 domain TS TaylorSeries . . . . .	2625
21.3.1 TaylorSeries (TS) . . . . .	2628
21.4 domain TEX TexFormat . . . . .	2630
21.4.1 product(product(i*j,i=a..b),j=c..d) fix . . . . .	2630
21.4.2 TexFormat (TEX) . . . . .	2635
21.5 domain TEXTFILE TextFile . . . . .	2647
21.5.1 TextFile (TEXTFILE) . . . . .	2651
21.6 domain SYMS TheSymbolTable . . . . .	2653
21.6.1 TheSymbolTable (SYMS) . . . . .	2655
21.7 domain M3D ThreeDimensionalMatrix . . . . .	2659
21.7.1 ThreeDimensionalMatrix (M3D) . . . . .	2661
21.8 domain VIEW3D ThreeDimensionalViewport . . . . .	2667
21.8.1 ThreeDimensionalViewport (VIEW3D) . . . . .	2669
21.9 domain SPACE3 ThreeSpace . . . . .	2688
21.9.1 ThreeSpace (SPACE3) . . . . .	2690
21.10domain TREE Tree . . . . .	2698
21.10.1 Tree (TREE) . . . . .	2699
21.11domain TUBE TubePlot . . . . .	2707
21.11.1 TubePlot (TUBE) . . . . .	2708
21.12domain TUPLE Tuple . . . . .	2710
21.12.1 Tuple (TUPLE) . . . . .	2711
21.13domain ARRAY2 TwoDimensionalArray . . . . .	2712
21.13.1 TwoDimensionalArray (ARRAY2) . . . . .	2722
21.14domain VIEW2D TwoDimensionalViewport . . . . .	2723
21.14.1 TwoDimensionalViewport (VIEW2D) . . . . .	2728
<b>22 Chapter U</b>	<b>2743</b>
22.1 domain UFPS UnivariateFormalPowerSeries . . . . .	2743
22.1.1 UnivariateFormalPowerSeries (UFPS) . . . . .	2746
22.2 domain ULS UnivariateLaurentSeries . . . . .	2748
22.2.1 UnivariateLaurentSeries (ULS) . . . . .	2752
22.3 domain ULSCONS UnivariateLaurentSeriesConstructor . . . . .	2755
22.3.1 UnivariateLaurentSeriesConstructor (ULSCONS) . . . . .	2760
22.4 domain UP UnivariatePolynomial . . . . .	2771
22.4.1 UnivariatePolynomial (UP) . . . . .	2784
22.5 domain UPXS UnivariatePuisseuxSeries . . . . .	2787
22.5.1 UnivariatePuisseuxSeries (UPXS) . . . . .	2790
22.6 domain UPXSCONS UnivariatePuisseuxSeriesConstructor . . . . .	2795

22.6.1	UnivariatePuisseuxSeriesConstructor (UPXSCONS)	2798
22.7	domain UPXSSING UnivariatePuisseuxSeriesWithExponentialSingularity	2806
22.7.1	UnivariatePuisseuxSeriesWithExponentialSingularity (UPXSSING)	2809
22.8	domain OREUP UnivariateSkewPolynomial	2815
22.8.1	UnivariateSkewPolynomial (OREUP)	2829
22.9	domain UTS UnivariateTaylorSeries	2831
22.9.1	UnivariateTaylorSeries (UTS)	2834
22.10	domain UTSZ UnivariateTaylorSeriesCZero	2840
22.10.1	UnivariateTaylorSeriesCZero (UTSZ)	2843
22.11	domain UNISEG UniversalSegment	2849
22.11.1	UniversalSegment (UNISEG)	2853
22.12	domain U32VEC U32Vector	2856
22.12.1	U32Vector (U32VEC)	2858
<b>23</b>	<b>Chapter V</b>	<b>2861</b>
23.1	domain VARIABLE Variable	2861
23.1.1	Variable (VARIABLE)	2862
23.2	domain VECTOR Vector	2863
23.2.1	Vector (VECTOR)	2867
23.3	domain VOID Void	2869
23.3.1	Void (VOID)	2871
<b>24</b>	<b>Chapter W</b>	<b>2873</b>
24.1	domain WP WeightedPolynomials	2873
24.1.1	WeightedPolynomials (WP)	2874
24.2	domain WUTSET WuWenTsunTriangularSet	2877
24.2.1	WuWenTsunTriangularSet (WUTSET)	2884
<b>25</b>	<b>Chapter X</b>	<b>2893</b>
25.1	domain XDPOLY XDistributedPolynomial	2893
25.1.1	XDistributedPolynomial (XDPOLY)	2895
25.2	domain XPBWPOLY XPBWPolynomial	2898
25.2.1	XPBWPolynomial (XPBWPOLY)	2915
25.3	domain XPOLY XPolynomial	2920
25.3.1	XPolynomial (XPOLY)	2926
25.4	domain XPR XPolynomialRing	2927
25.4.1	XPolynomialRing (XPR)	2935
25.5	domain XRPOLY XRecursivePolynomial	2939
25.5.1	XRecursivePolynomial (XRPOLY)	2941
<b>26</b>	<b>Chapter Y</b>	<b>2949</b>
<b>27</b>	<b>Chapter Z</b>	<b>2951</b>

<b>28 The bootstrap code</b>	<b>2953</b>
28.1 BOOLEAN.lsp . . . . .	2953
28.2 CHAR.lsp BOOTSTRAP . . . . .	2958
28.3 DFLOAT.lsp BOOTSTRAP . . . . .	2962
28.4 ILIST.lsp BOOTSTRAP . . . . .	2978
28.5 INT.lsp BOOTSTRAP . . . . .	2990
28.6 ISTRING.lsp BOOTSTRAP . . . . .	3001
28.7 LIST.lsp BOOTSTRAP . . . . .	3019
28.8 NNI.lsp BOOTSTRAP . . . . .	3025
28.9 OUTFORM.lsp BOOTSTRAP . . . . .	3028
28.10PI.lsp BOOTSTRAP . . . . .	3042
28.11PRIMARR.lsp BOOTSTRAP . . . . .	3044
28.12REF.lsp BOOTSTRAP . . . . .	3047
28.13SINT.lsp BOOTSTRAP . . . . .	3050
28.14SYMBOL.lsp BOOTSTRAP . . . . .	3063
28.15VECTOR.lsp BOOTSTRAP . . . . .	3079
<b>29 Chunk collections</b>	<b>3083</b>
<b>30 Index</b>	<b>3093</b>

## Volume 10.4: Axiom Algebra: Packages

<b>1</b>	<b>Chapter Overview</b>	<b>1</b>
<b>2</b>	<b>Chapter A</b>	<b>3</b>
2.1	package AFALGGRO AffineAlgebraicSetComputeWithGroebnerBasis . . . . .	3
2.1.1	AffineAlgebraicSetComputeWithGroebnerBasis (AFALGGRO) . . . . .	4
2.2	package AFALGRES AffineAlgebraicSetComputeWithResultant . . . . .	8
2.2.1	AffineAlgebraicSetComputeWithResultant (AFALGRES) . . . . .	9
2.3	package AF AlgebraicFunction . . . . .	13
2.3.1	AlgebraicFunction (AF) . . . . .	13
2.4	package INTHERAL AlgebraicHermiteIntegration . . . . .	19
2.4.1	AlgebraicHermiteIntegration (INTHERAL) . . . . .	19
2.5	package INTALG AlgebraicIntegrate . . . . .	21
2.5.1	AlgebraicIntegrate (INTALG) . . . . .	21
2.6	package INTAF AlgebraicIntegration . . . . .	28
2.6.1	AlgebraicIntegration (INTAF) . . . . .	28
2.7	package ALGMANIP AlgebraicManipulations . . . . .	30
2.7.1	AlgebraicManipulations (ALGMANIP) . . . . .	30
2.8	package ALGMFACT AlgebraicMultFact . . . . .	35
2.8.1	AlgebraicMultFact (ALGMFACT) . . . . .	35
2.9	package ALGPKG AlgebraPackage . . . . .	37
2.9.1	AlgebraPackage (ALGPKG) . . . . .	37
2.10	package ALGFACT AlgFactor . . . . .	47
2.10.1	AlgFactor (ALGFACT) . . . . .	47
2.11	package INTPACK AnnaNumericalIntegrationPackage . . . . .	50
2.11.1	AnnaNumericalIntegrationPackage (INTPACK) . . . . .	50
2.12	package OPTPACK AnnaNumericalOptimizationPackage . . . . .	61
2.12.1	AnnaNumericalOptimizationPackage (OPTPACK) . . . . .	61
2.13	package ODEPACK AnnaOrdinaryDifferentialEquationPackage . . . . .	69
2.13.1	AnnaOrdinaryDifferentialEquationPackage (ODEPACK) . . . . .	69
2.14	package PDEPACK AnnaPartialDifferentialEquationPackage . . . . .	78
2.14.1	AnnaPartialDifferentialEquationPackage (PDEPACK) . . . . .	78
2.15	package ANY1 AnyFunctions1 . . . . .	84
2.15.1	AnyFunctions1 (ANY1) . . . . .	84
2.16	package API ApplicationProgramInterface . . . . .	86
2.16.1	ApplicationProgramInterface (API) . . . . .	90
2.17	package APPRULE ApplyRules . . . . .	91
2.17.1	ApplyRules (APPRULE) . . . . .	91
2.18	package APPLYORE ApplyUnivariateSkewPolynomial . . . . .	94
2.18.1	ApplyUnivariateSkewPolynomial (APPLYORE) . . . . .	94
2.19	package ASSOCEQ AssociatedEquations . . . . .	96
2.19.1	AssociatedEquations (ASSOCEQ) . . . . .	96
2.20	package PMPRED AttachPredicates . . . . .	99
2.20.1	AttachPredicates (PMPRED) . . . . .	99

2.21	package AXSERV AxiomServer . . . . .	100
2.21.1	AxiomServer (AXSERV) . . . . .	100
<b>3</b>	<b>Chapter B</b>	<b>117</b>
3.1	package BALFACT BalancedFactorisation . . . . .	117
3.1.1	BalancedFactorisation (BALFACT) . . . . .	117
3.2	package BOP1 BasicOperatorFunctions1 . . . . .	119
3.2.1	BasicOperatorFunctions1 (BOP1) . . . . .	119
3.3	package BEZIER Bezier . . . . .	122
3.3.1	Bezier (BEZIER) . . . . .	126
3.4	package BEZOUT BezoutMatrix . . . . .	128
3.4.1	BezoutMatrix (BEZOUT) . . . . .	128
3.5	package BLUPPACK BlowUpPackage . . . . .	131
3.5.1	BlowUpPackage (BLUPPACK) . . . . .	133
3.6	package BOUNDZRO BoundIntegerRoots . . . . .	138
3.6.1	BoundIntegerRoots (BOUNDZRO) . . . . .	138
3.7	package BRILL BrillhartTests . . . . .	141
3.7.1	BrillhartTests (BRILL) . . . . .	141
<b>4</b>	<b>Chapter C</b>	<b>145</b>
4.1	package CARTEN2 CartesianTensorFunctions2 . . . . .	145
4.1.1	CartesianTensorFunctions2 (CARTEN2) . . . . .	145
4.2	package CHVAR ChangeOfVariable . . . . .	147
4.2.1	ChangeOfVariable (CHVAR) . . . . .	147
4.3	package CPIMA CharacteristicPolynomialInMonogenicalAlgebra . . . . .	150
4.3.1	CharacteristicPolynomialInMonogenicalAlgebra (CPIMA) . . . . .	150
4.4	package CHARPOL CharacteristicPolynomialPackage . . . . .	152
4.4.1	CharacteristicPolynomialPackage (CHARPOL) . . . . .	152
4.5	package IBACHIN ChineseRemainderToolsForIntegralBases . . . . .	153
4.5.1	ChineseRemainderToolsForIntegralBases (IBACHIN) . . . . .	153
4.6	package CVMP CoerceVectorMatrixPackage . . . . .	158
4.6.1	CoerceVectorMatrixPackage (CVMP) . . . . .	158
4.7	package COMBF CombinatorialFunction . . . . .	159
4.7.1	CombinatorialFunction (COMBF) . . . . .	163
4.8	package CDEN CommonDenominator . . . . .	175
4.8.1	CommonDenominator (CDEN) . . . . .	175
4.9	package COMMONOP CommonOperators . . . . .	177
4.9.1	CommonOperators (COMMONOP) . . . . .	177
4.10	package COMMUPC CommuteUnivariatePolynomialCategory . . . . .	182
4.10.1	CommuteUnivariatePolynomialCategory (COMMUPC) . . . . .	182
4.11	package COMPFAC ComplexFactorization . . . . .	183
4.11.1	ComplexFactorization (COMPFAC) . . . . .	183
4.12	package COMPLEX2 ComplexFunctions2 . . . . .	186
4.12.1	ComplexFunctions2 (COMPLEX2) . . . . .	186
4.13	package CINTSLPE ComplexIntegerSolveLinearPolynomialEquation . . . . .	187
4.13.1	ComplexIntegerSolveLinearPolynomialEquation (CINTSLPE) . . . . .	187

4.14	package COMPLPAT ComplexPattern . . . . .	189
4.14.1	ComplexPattern (COMPLPAT) . . . . .	189
4.15	package CPMATCH ComplexPatternMatch . . . . .	190
4.15.1	ComplexPatternMatch (CPMATCH) . . . . .	190
4.16	package CRFP ComplexRootFindingPackage . . . . .	192
4.16.1	ComplexRootFindingPackage (CRFP) . . . . .	192
4.17	package CMPLXRT ComplexRootPackage . . . . .	204
4.17.1	ComplexRootPackage (CMPLXRT) . . . . .	204
4.18	package CTRIGMNP ComplexTrigonometricManipulations . . . . .	206
4.18.1	ComplexTrigonometricManipulations (CTRIGMNP) . . . . .	206
4.19	package ODECONST ConstantLODE . . . . .	209
4.19.1	ConstantLODE (ODECONST) . . . . .	209
4.20	package COORDSYS CoordinateSystems . . . . .	211
4.20.1	CoordinateSystems (COORDSYS) . . . . .	211
4.21	package CRAPACK CRAPackage . . . . .	216
4.21.1	CRAPackage (CRAPACK) . . . . .	216
4.22	package CYCLES CycleIndicators . . . . .	218
4.22.1	CycleIndicators (CYCLES) . . . . .	237
4.23	package CSTTOOLS CyclicStreamTools . . . . .	242
4.23.1	CyclicStreamTools (CSTTOOLS) . . . . .	242
4.24	package CYCLOTOM CyclotomicPolynomialPackage . . . . .	244
4.24.1	CyclotomicPolynomialPackage (CYCLOTOM) . . . . .	244
<b>5</b>	<b>Chapter D</b>	<b>247</b>
5.1	package DFINTTLS DefiniteIntegrationTools . . . . .	247
5.1.1	DefiniteIntegrationTools (DFINTTLS) . . . . .	247
5.2	package DEGRED DegreeReductionPackage . . . . .	253
5.2.1	DegreeReductionPackage (DEGRED) . . . . .	253
5.3	package DTP DesingTreePackage . . . . .	254
5.3.1	DesingTreePackage (DTP) . . . . .	256
5.4	package DIOSP DiophantineSolutionPackage . . . . .	265
5.4.1	DiophantineSolutionPackage (DIOSP) . . . . .	265
5.5	package DIRPROD2 DirectProductFunctions2 . . . . .	269
5.5.1	DirectProductFunctions2 (DIRPROD2) . . . . .	269
5.6	package DLP DiscreteLogarithmPackage . . . . .	271
5.6.1	DiscreteLogarithmPackage (DLP) . . . . .	271
5.7	package DISPLAY DisplayPackage . . . . .	273
5.7.1	DisplayPackage (DISPLAY) . . . . .	273
5.8	package DDFACT DistinctDegreeFactorize . . . . .	276
5.8.1	DistinctDegreeFactorize (DDFACT) . . . . .	276
5.9	package DFSFUN DoubleFloatSpecialFunctions . . . . .	282
5.9.1	DoubleFloatSpecialFunctions (DFSFUN) . . . . .	297
5.9.2	The Exponential Integral . . . . .	301
5.9.3	En:(PI,R)→OPR . . . . .	307
5.9.4	The Ei Function . . . . .	307
5.9.5	The Fresnel Integral[?, ?] . . . . .	334



5.10	package DBLRESP DoubleResultantPackage . . . . .	338
5.10.1	DoubleResultantPackage (DBLRESP) . . . . .	338
5.11	package DRAWCX DrawComplex . . . . .	340
5.11.1	DrawComplex (DRAWCX) . . . . .	340
5.12	package DRAWHACK DrawNumericHack . . . . .	344
5.12.1	DrawNumericHack (DRAWHACK) . . . . .	344
5.13	package DROPT0 DrawOptionFunctions0 . . . . .	345
5.13.1	DrawOptionFunctions0 (DROPT0) . . . . .	345
5.14	package DROPT1 DrawOptionFunctions1 . . . . .	349
5.14.1	DrawOptionFunctions1 (DROPT1) . . . . .	349
5.15	package D01AGNT d01AgentsPackage . . . . .	351
5.15.1	d01AgentsPackage (D01AGNT) . . . . .	351
5.16	package D01WGTS d01WeightsPackage . . . . .	357
5.16.1	d01WeightsPackage (D01WGTS) . . . . .	357
5.17	package D02AGNT d02AgentsPackage . . . . .	363
5.17.1	d02AgentsPackage (D02AGNT) . . . . .	363
5.18	package D03AGNT d03AgentsPackage . . . . .	369
5.18.1	d03AgentsPackage (D03AGNT) . . . . .	369
<b>6</b>	<b>Chapter E</b>	<b>373</b>
6.1	package EP EigenPackage . . . . .	373
6.1.1	EigenPackage (EP) . . . . .	373
6.2	package EF ElementaryFunction . . . . .	379
6.2.1	ElementaryFunction (EF) . . . . .	391
6.3	package DEFINTEF ElementaryFunctionDefiniteIntegration . . . . .	409
6.3.1	ElementaryFunctionDefiniteIntegration (DEFINTEF) . . . . .	409
6.4	package LODEEF ElementaryFunctionLODESolver . . . . .	414
6.4.1	ElementaryFunctionLODESolver (LODEEF) . . . . .	414
6.5	package ODEEF ElementaryFunctionODESolver . . . . .	420
6.5.1	ElementaryFunctionODESolver (ODEEF) . . . . .	420
6.6	package SIGNEF ElementaryFunctionSign . . . . .	426
6.6.1	ElementaryFunctionSign (SIGNEF) . . . . .	426
6.7	package EFSTRUC ElementaryFunctionStructurePackage . . . . .	430
6.7.1	ElementaryFunctionStructurePackage (EFSTRUC) . . . . .	430
6.8	package EFULS ElementaryFunctionsUnivariateLaurentSeries . . . . .	439
6.8.1	ElementaryFunctionsUnivariateLaurentSeries (EFULS) . . . . .	439
6.9	package EFUPXS ElementaryFunctionsUnivariatePuisseuxSeries . . . . .	447
6.9.1	ElementaryFunctionsUnivariatePuisseuxSeries (EFUPXS) . . . . .	447
6.10	package INTEF ElementaryIntegration . . . . .	453
6.10.1	ElementaryIntegration (INTEF) . . . . .	453
6.11	package RDEEF ElementaryRischDE . . . . .	462
6.11.1	ElementaryRischDE (RDEEF) . . . . .	462
6.12	package RDEEFS ElementaryRischDESystem . . . . .	470
6.12.1	ElementaryRischDESystem (RDEEFS) . . . . .	470
6.13	package ELFUTS EllipticFunctionsUnivariateTaylorSeries . . . . .	473
6.13.1	EllipticFunctionsUnivariateTaylorSeries (ELFUTS) . . . . .	473

6.14	package EQ2 EquationFunctions2 . . . . .	475
6.14.1	EquationFunctions2 (EQ2) . . . . .	475
6.15	package ERROR ErrorFunctions . . . . .	476
6.15.1	ErrorFunctions (ERROR) . . . . .	476
6.16	package GBEUCLID EuclideanGroebnerBasisPackage . . . . .	478
6.16.1	EuclideanGroebnerBasisPackage (GBEUCLID) . . . . .	501
6.17	package EVALCYC EvaluateCycleIndicators . . . . .	513
6.17.1	EvaluateCycleIndicators (EVALCYC) . . . . .	513
6.18	package ESCONT ExpertSystemContinuityPackage . . . . .	514
6.18.1	ExpertSystemContinuityPackage (ESCONT) . . . . .	514
6.19	package ESCONT1 ExpertSystemContinuityPackage1 . . . . .	520
6.19.1	ExpertSystemContinuityPackage1 (ESCONT1) . . . . .	520
6.20	package ESTOOLS ExpertSystemToolsPackage . . . . .	522
6.20.1	ExpertSystemToolsPackage (ESTOOLS) . . . . .	522
6.21	package ESTOOLS1 ExpertSystemToolsPackage1 . . . . .	530
6.21.1	ExpertSystemToolsPackage1 (ESTOOLS1) . . . . .	530
6.22	package ESTOOLS2 ExpertSystemToolsPackage2 . . . . .	531
6.22.1	ExpertSystemToolsPackage2 (ESTOOLS2) . . . . .	531
6.23	package EXPR2 ExpressionFunctions2 . . . . .	532
6.23.1	ExpressionFunctions2 (EXPR2) . . . . .	532
6.24	package EXPRSOL ExpressionSolve . . . . .	533
6.24.1	Bugs . . . . .	533
6.24.2	ExpressionSolve (EXPRSOL) . . . . .	534
6.25	package ES1 ExpressionSpaceFunctions1 . . . . .	536
6.25.1	ExpressionSpaceFunctions1 (ES1) . . . . .	536
6.26	package ES2 ExpressionSpaceFunctions2 . . . . .	538
6.26.1	ExpressionSpaceFunctions2 (ES2) . . . . .	538
6.27	package EXPRODE ExpressionSpaceODESolver . . . . .	539
6.27.1	ExpressionSpaceODESolver (EXPRODE) . . . . .	539
6.28	package OMEXPR ExpressionToOpenMath . . . . .	544
6.28.1	ExpressionToOpenMath (OMEXPR) . . . . .	544
6.29	package EXPR2UPS ExpressionToUnivariatePowerSeries . . . . .	550
6.29.1	ExpressionToUnivariatePowerSeries (EXPR2UPS) . . . . .	550
6.30	package EXPRTUBE ExpressionTubePlot . . . . .	557
6.30.1	ExpressionTubePlot (EXPRTUBE) . . . . .	557
6.31	package EXP3D Export3D . . . . .	561
6.31.1	Export3D (EXP3D) . . . . .	562
6.32	package E04AGNT e04AgentsPackage . . . . .	565
6.32.1	e04AgentsPackage (E04AGNT) . . . . .	565
<b>7</b>	<b>Chapter F</b>	<b>573</b>
7.1	package FACTFUNC FactoredFunctions . . . . .	573
7.1.1	FactoredFunctions (FACTFUNC) . . . . .	573
7.2	package FR2 FactoredFunctions2 . . . . .	575
7.2.1	FactoredFunctions2 (FR2) . . . . .	577
7.3	package FRUTIL FactoredFunctionUtilities . . . . .	579

7.3.1	FactoredFunctionUtilities (FRUTIL) . . . . .	579
7.4	package FACUTIL FactoringUtilities . . . . .	581
7.4.1	FactoringUtilities (FACUTIL) . . . . .	581
7.5	package FACTEXT FactorisationOverPseudoAlgebraicClosureOfAlgExtOfRationalNumber . . . . .	583
7.5.1	FactorisationOverPseudoAlgebraicClosureOfAlgExtOfRationalNumber (FACTEXT) . . . . .	584
7.6	package FACTRN FactorisationOverPseudoAlgebraicClosureOfRationalNumber . . . . .	587
7.6.1	FactorisationOverPseudoAlgebraicClosureOfRationalNumber (FACTRN) . . . . .	589
7.7	package FGLMICPK FGLMIfCanPackage . . . . .	592
7.7.1	FGLMIfCanPackage (FGLMICPK) . . . . .	592
7.8	package FORDER FindOrderFinite . . . . .	594
7.8.1	FindOrderFinite (FORDER) . . . . .	594
7.9	package FAMR2 FiniteAbelianMonoidRingFunctions2 . . . . .	596
7.9.1	FiniteAbelianMonoidRingFunctions2 (FAMR2) . . . . .	596
7.10	package FDIV2 FiniteDivisorFunctions2 . . . . .	597
7.10.1	FiniteDivisorFunctions2 (FDIV2) . . . . .	597
7.11	package FFFACTSE FiniteFieldFactorizationWithSizeParseBySideEffect . . . . .	598
7.11.1	FiniteFieldFactorizationWithSizeParseBySideEffect (FFFACTSE) . . . . .	599
7.12	package FFF FiniteFieldFunctions . . . . .	605
7.12.1	FiniteFieldFunctions (FFF) . . . . .	605
7.13	package FFHOM FiniteFieldHomomorphisms . . . . .	610
7.13.1	FiniteFieldHomomorphisms (FFHOM) . . . . .	610
7.14	package FFPOLY FiniteFieldPolynomialPackage . . . . .	618
7.14.1	FiniteFieldPolynomialPackage (FFPOLY) . . . . .	618
7.15	package FFPOLY2 FiniteFieldPolynomialPackage2 . . . . .	639
7.15.1	FiniteFieldPolynomialPackage2 (FFPOLY2) . . . . .	639
7.16	package FFSLPE FiniteFieldSolveLinearPolynomialEquation . . . . .	642
7.16.1	FiniteFieldSolveLinearPolynomialEquation (FFSLPE) . . . . .	642
7.17	package FFSQFR FiniteFieldSquareFreeDecomposition . . . . .	643
7.17.1	FiniteFieldSquareFreeDecomposition (FFSQFR) . . . . .	644
7.18	package FLAGG2 FiniteLinearAggregateFunctions2 . . . . .	647
7.18.1	FiniteLinearAggregateFunctions2 (FLAGG2) . . . . .	647
7.19	package FLASORT FiniteLinearAggregateSort . . . . .	650
7.19.1	FiniteLinearAggregateSort (FLASORT) . . . . .	650
7.20	package FSAGG2 FiniteSetAggregateFunctions2 . . . . .	653
7.20.1	FiniteSetAggregateFunctions2 (FSAGG2) . . . . .	653
7.21	package FLOATCP FloatingComplexPackage . . . . .	654
7.21.1	FloatingComplexPackage (FLOATCP) . . . . .	654
7.22	package FLOATRP FloatingRealPackage . . . . .	658
7.22.1	FloatingRealPackage (FLOATRP) . . . . .	658
7.23	package FCPAK1 FortranCodePackage1 . . . . .	661
7.23.1	FortranCodePackage1 (FCPAK1) . . . . .	661
7.24	package FOP FortranOutputStackPackage . . . . .	664
7.24.1	FortranOutputStackPackage (FOP) . . . . .	664

7.25	package FORT FortranPackage . . . . .	667
7.25.1	FortranPackage (FORT) . . . . .	667
7.26	package FRIDEAL2 FractionalIdealFunctions2 . . . . .	669
7.26.1	FractionalIdealFunctions2 (FRIDEAL2) . . . . .	669
7.27	package FFFG FractionFreeFastGaussian . . . . .	671
7.27.1	FractionFreeFastGaussian (FFFG) . . . . .	671
7.28	package FFFGF FractionFreeFastGaussianFractions . . . . .	681
7.28.1	FractionFreeFastGaussianFractions (FFFGF) . . . . .	681
7.29	package FRAC2 FractionFunctions2 . . . . .	684
7.29.1	FractionFunctions2 (FRAC2) . . . . .	684
7.30	package FRNAAF2 FramedNonAssociativeAlgebraFunctions2 . . . . .	685
7.30.1	FramedNonAssociativeAlgebraFunctions2 (FRNAAF2) . . . . .	685
7.31	package FSPECF FunctionalSpecialFunction . . . . .	687
7.31.1	FunctionalSpecialFunction (FSPECF) . . . . .	687
7.31.2	differentiation of special functions . . . . .	693
7.32	package FFCAT2 FunctionFieldCategoryFunctions2 . . . . .	696
7.32.1	FunctionFieldCategoryFunctions2 (FFCAT2) . . . . .	696
7.33	package FFINTBAS FunctionFieldIntegralBasis . . . . .	697
7.33.1	FunctionFieldIntegralBasis (FFINTBAS) . . . . .	697
7.34	package PMASSFS FunctionSpaceAssertions . . . . .	700
7.34.1	FunctionSpaceAssertions (PMASSFS) . . . . .	700
7.35	package PMPREDFS FunctionSpaceAttachPredicates . . . . .	702
7.35.1	FunctionSpaceAttachPredicates (PMPREDFS) . . . . .	702
7.36	package FSCINT FunctionSpaceComplexIntegration . . . . .	704
7.36.1	FunctionSpaceComplexIntegration (FSCINT) . . . . .	704
7.37	package FS2 FunctionSpaceFunctions2 . . . . .	706
7.37.1	FunctionSpaceFunctions2 (FS2) . . . . .	706
7.38	package FSINT FunctionSpaceIntegration . . . . .	708
7.38.1	FunctionSpaceIntegration (FSINT) . . . . .	708
7.39	package FSPRMELT FunctionSpacePrimitiveElement . . . . .	711
7.39.1	FunctionSpacePrimitiveElement (FSPRMELT) . . . . .	711
7.40	package FSRED FunctionSpaceReduce . . . . .	714
7.40.1	FunctionSpaceReduce (FSRED) . . . . .	714
7.41	package SUMFS FunctionSpaceSum . . . . .	716
7.41.1	FunctionSpaceSum (SUMFS) . . . . .	716
7.42	package FS2EXPPX FunctionSpaceToExponentialExpansion . . . . .	718
7.42.1	FunctionSpaceToExponentialExpansion (FS2EXPPX) . . . . .	718
7.43	package FS2UPS FunctionSpaceToUnivariatePowerSeries . . . . .	729
7.43.1	FunctionSpaceToUnivariatePowerSeries (FS2UPS) . . . . .	729
7.44	package FSUPFACT FunctionSpaceUnivariatePolynomialFactor . . . . .	745
7.44.1	FunctionSpaceUnivariatePolynomialFactor (FSUPFACT) . . . . .	745

<b>8 Chapter G</b>	<b>751</b>
8.1 package GALFACTU GaloisGroupFactorizationUtilities . . . . .	751
8.1.1 GaloisGroupFactorizationUtilities (GALFACTU) . . . . .	751
8.2 package GALFACT GaloisGroupFactorizer . . . . .	755
8.2.1 GaloisGroupFactorizer (GALFACT) . . . . .	755
8.3 package GALPOLYU GaloisGroupPolynomialUtilities . . . . .	772
8.3.1 GaloisGroupPolynomialUtilities (GALPOLYU) . . . . .	772
8.4 package GALUTIL GaloisGroupUtilities . . . . .	775
8.4.1 GaloisGroupUtilities (GALUTIL) . . . . .	775
8.5 package GAUSSFAC GaussianFactorizationPackage . . . . .	778
8.5.1 GaussianFactorizationPackage (GAUSSFAC) . . . . .	778
8.6 package GHENSEL GeneralHenselPackage . . . . .	782
8.6.1 GeneralHenselPackage (GHENSEL) . . . . .	782
8.7 package GENMFACT GeneralizedMultivariateFactorize . . . . .	786
8.7.1 GeneralizedMultivariateFactorize (GENMFACT) . . . . .	786
8.8 package GPAFF GeneralPackageForAlgebraicFunctionField . . . . .	787
8.8.1 GeneralPackageForAlgebraicFunctionField (GPAFF) . . . . .	789
8.9 package GENPGCD GeneralPolynomialGcdPackage . . . . .	803
8.9.1 GeneralPolynomialGcdPackage (GENPGCD) . . . . .	803
8.10 package GENUPS GenerateUnivariatePowerSeries . . . . .	817
8.10.1 GenerateUnivariatePowerSeries (GENUPS) . . . . .	817
8.11 package GENEEZ GenExEuclid . . . . .	821
8.11.1 GenExEuclid (GENEEZ) . . . . .	821
8.12 package GENUFACT GenUFactorize . . . . .	826
8.12.1 GenUFactorize (GENUFACT) . . . . .	826
8.13 package INTG0 GenusZeroIntegration . . . . .	828
8.13.1 GenusZeroIntegration (INTG0) . . . . .	828
8.14 package GDRAW GnuDraw . . . . .	834
8.14.1 GnuDraw (GDRAW) . . . . .	835
8.15 package GOSPER GosperSummationMethod . . . . .	837
8.15.1 GosperSummationMethod (GOSPER) . . . . .	837
8.16 package GRDEF GraphicsDefaults . . . . .	842
8.16.1 GraphicsDefaults (GRDEF) . . . . .	842
8.17 package GRAY GrayCode . . . . .	845
8.17.1 GrayCode (GRAY) . . . . .	845
8.18 package GBF GroebnerFactorizationPackage . . . . .	847
8.18.1 GroebnerFactorizationPackage (GBF) . . . . .	851
8.19 package GBINTERN GroebnerInternalPackage . . . . .	859
8.19.1 GroebnerInternalPackage (GBINTERN) . . . . .	859
8.20 package GB GroebnerPackage . . . . .	869
8.20.1 GroebnerPackage (GB) . . . . .	895
8.21 package GROEBSOL GroebnerSolve . . . . .	899
8.21.1 GroebnerSolve (GROEBSOL) . . . . .	899
8.22 package GUESS Guess . . . . .	903
8.22.1 Guess (GUESS) . . . . .	904
8.22.2 general utilities . . . . .	911

8.22.3	guessing rational functions with an exponential term . . . . .	912
8.22.4	guessing rational functions with a binomial term . . . . .	922
8.22.5	Hermite Padé interpolation . . . . .	929
8.22.6	guess – applying operators recursively . . . . .	950
8.23	package GUESSAN GuessAlgebraicNumber . . . . .	953
8.23.1	GuessAlgebraicNumber (GUESSAN) . . . . .	953
8.24	package GUESSF GuessFinite . . . . .	954
8.24.1	GuessFinite (GUESSF) . . . . .	954
8.25	package GUESSF1 GuessFiniteFunctions . . . . .	955
8.25.1	GuessFiniteFunctions (GUESSF1) . . . . .	955
8.26	package GUESSINT GuessInteger . . . . .	956
8.26.1	GuessInteger (GUESSINT) . . . . .	956
8.27	package GUESSP GuessPolynomial . . . . .	957
8.27.1	GuessPolynomial (GUESSP) . . . . .	957
8.28	package GUESSUP GuessUnivariatePolynomial . . . . .	958
8.28.1	GuessUnivariatePolynomial (GUESSUP) . . . . .	958
<b>9</b>	<b>Chapter H</b>	<b>963</b>
9.1	package HB HallBasis . . . . .	963
9.1.1	HallBasis (HB) . . . . .	963
9.2	package HEUGCD HeuGcd . . . . .	966
9.2.1	HeuGcd (HEUGCD) . . . . .	966
<b>10</b>	<b>Chapter I</b>	<b>973</b>
10.1	package IDECOMP IdealDecompositionPackage . . . . .	973
10.1.1	IdealDecompositionPackage (IDECOMP) . . . . .	973
10.2	package INCRMAPS IncrementingMaps . . . . .	982
10.2.1	IncrementingMaps (INCRMAPS) . . . . .	982
10.3	package INFPROD0 InfiniteProductCharacteristicZero . . . . .	983
10.3.1	InfiniteProductCharacteristicZero (INFPROD0) . . . . .	983
10.4	package INPRODFP InfiniteProductFiniteField . . . . .	985
10.4.1	InfiniteProductFiniteField (INPRODFP) . . . . .	985
10.5	package INPRODPF InfiniteProductPrimeField . . . . .	988
10.5.1	InfiniteProductPrimeField (INPRODPF) . . . . .	988
10.6	package ITFUN2 InfiniteTupleFunctions2 . . . . .	990
10.6.1	InfiniteTupleFunctions2 (ITFUN2) . . . . .	990
10.7	package ITFUN3 InfiniteTupleFunctions3 . . . . .	991
10.7.1	InfiniteTupleFunctions3 (ITFUN3) . . . . .	991
10.8	package INFINITY Infinity . . . . .	992
10.8.1	Infinity (INFINITY) . . . . .	992
10.9	package IALGFACT InnerAlgFactor . . . . .	993
10.9.1	InnerAlgFactor (IALGFACT) . . . . .	993
10.10	package ICDEN InnerCommonDenominator . . . . .	996
10.10.1	InnerCommonDenominator (ICDEN) . . . . .	996
10.11	package IMATLIN InnerMatrixLinearAlgebraFunctions . . . . .	998
10.11.1	InnerMatrixLinearAlgebraFunctions (IMATLIN) . . . . .	998

10.12package IMATQF InnerMatrixQuotientFieldFunctions . . . . .	1003
10.12.1 InnerMatrixQuotientFieldFunctions (IMATQF) . . . . .	1003
10.13package INMODGCD InnerModularGcd . . . . .	1005
10.13.1 InnerModularGcd (INMODGCD) . . . . .	1005
10.14package INNMFACt InnerMultFact . . . . .	1011
10.14.1 InnerMultFact (INNMFACt) . . . . .	1011
10.15package INBFF InnerNormalBasisFieldFunctions . . . . .	1020
10.15.1 InnerNormalBasisFieldFunctions (INBFF) . . . . .	1020
10.16package INEP InnerNumericEigenPackage . . . . .	1028
10.16.1 InnerNumericEigenPackage (INEP) . . . . .	1028
10.17package INFSP InnerNumericFloatSolvePackage . . . . .	1033
10.17.1 InnerNumericFloatSolvePackage (INFSP) . . . . .	1033
10.18package INPSIGN InnerPolySign . . . . .	1037
10.18.1 InnerPolySign (INPSIGN) . . . . .	1037
10.19package ISUMP InnerPolySum . . . . .	1039
10.19.1 InnerPolySum (ISUMP) . . . . .	1039
10.20package ITRIGMNP InnerTrigonometricManipulations . . . . .	1041
10.20.1 InnerTrigonometricManipulations (ITRIGMNP) . . . . .	1041
10.21package INFORM1 InputFormFunctions1 . . . . .	1045
10.21.1 InputFormFunctions1 (INFORM1) . . . . .	1045
10.22package INTERGB InterfaceGroebnerPackage . . . . .	1046
10.22.1 InterfaceGroebnerPackage (INTERGB) . . . . .	1047
10.23package INTBIT IntegerBits . . . . .	1049
10.23.1 IntegerBits (INTBIT) . . . . .	1049
10.24package COMBINAT IntegerCombinatoricFunctions . . . . .	1050
10.24.1 IntegerCombinatoricFunctions (COMBINAT) . . . . .	1053
10.25package INTFACT IntegerFactorizationPackage . . . . .	1056
10.25.1 IntegerFactorizationPackage (INTFACT) . . . . .	1056
10.25.2 squareFree . . . . .	1057
10.25.3 PollardSmallFactor . . . . .	1058
10.25.4 BasicSieve . . . . .	1060
10.25.5 BasicMethod . . . . .	1061
10.25.6 factor . . . . .	1062
10.26package ZLINDEP IntegerLinearDependence . . . . .	1063
10.26.1 IntegerLinearDependence (ZLINDEP) . . . . .	1067
10.27package INTHEORY IntegerNumberTheoryFunctions . . . . .	1068
10.27.1 IntegerNumberTheoryFunctions (INTHEORY) . . . . .	1082
10.28package PRIMES IntegerPrimesPackage . . . . .	1087
10.28.1 IntegerPrimesPackage (PRIMES) . . . . .	1088
10.28.2 smallPrimes . . . . .	1089
10.28.3 primes . . . . .	1094
10.28.4 rabinProvesCompositeSmall . . . . .	1094
10.28.5 rabinProvesComposite . . . . .	1095
10.28.6 prime? . . . . .	1095
10.28.7 nextPrime . . . . .	1097
10.28.8 prevPrime . . . . .	1097

10.29package INTRET IntegerRetractions . . . . .	1098
10.29.1 IntegerRetractions (INTRET) . . . . .	1098
10.30package IROOT IntegerRoots . . . . .	1099
10.30.1 IntegerRoots (IROOT) . . . . .	1099
10.30.2 perfectSquare? . . . . .	1100
10.30.3 perfectNthPower? . . . . .	1101
10.30.4 perfectNthRoot . . . . .	1101
10.30.5 approxNthRoot . . . . .	1101
10.30.6 perfectNthRoot . . . . .	1102
10.30.7 perfectSqrt . . . . .	1102
10.30.8 approxSqrt . . . . .	1102
10.31package INTSLPE IntegerSolveLinearPolynomialEquation . . . . .	1103
10.31.1 IntegerSolveLinearPolynomialEquation (INTSLPE) . . . . .	1103
10.32package IBATool IntegralBasisTools . . . . .	1105
10.32.1 IntegralBasisTools (IBATool) . . . . .	1105
10.33package IBPTOOLS IntegralBasisPolynomialTools . . . . .	1109
10.33.1 IntegralBasisPolynomialTools (IBPTOOLS) . . . . .	1109
10.34package IR2 IntegrationResultFunctions2 . . . . .	1111
10.34.1 IntegrationResultFunctions2 (IR2) . . . . .	1111
10.35package IRRF2F IntegrationResultRFToFunction . . . . .	1113
10.35.1 IntegrationResultRFToFunction (IRRF2F) . . . . .	1113
10.36package IR2F IntegrationResultToFunction . . . . .	1115
10.36.1 IntegrationResultToFunction (IR2F) . . . . .	1115
10.37package INTTOOLS IntegrationTools . . . . .	1120
10.37.1 IntegrationTools (INTTOOLS) . . . . .	1120
10.38package IPRNTPK InternalPrintPackage . . . . .	1124
10.38.1 InternalPrintPackage (IPRNTPK) . . . . .	1124
10.39package IRURPK InternalRationalUnivariateRepresentationPackage . . . . .	1125
10.39.1 InternalRationalUnivariateRepresentationPackage (IRURPK) . . . . .	1125
10.40package INTFRSP InterpolateFormsPackage . . . . .	1130
10.40.1 InterpolateFormsPackage (INTFRSP) . . . . .	1131
10.41package INTDIVP IntersectionDivisorPackage . . . . .	1137
10.41.1 IntersectionDivisorPackage (INTDIVP) . . . . .	1138
10.42package IRREDFFX IrredPolyOverFiniteField . . . . .	1141
10.42.1 IrredPolyOverFiniteField (IRREDFFX) . . . . .	1141
10.43package IRSN IrrRepSymNatPackage . . . . .	1143
10.43.1 IrrRepSymNatPackage (IRSN) . . . . .	1143
10.44package INVLAPLA InverseLaplaceTransform . . . . .	1150
10.44.1 InverseLaplaceTransform (INVLAPLA) . . . . .	1150



<b>12 Chapter K</b>	<b>1155</b>
12.1 package KERNEL2 KernelFunctions2 . . . . .	1155
12.1.1 KernelFunctions2 (KERNEL2) . . . . .	1155
12.2 package KOVACIC Kovacic . . . . .	1156
12.2.1 Kovacic (KOVACIC) . . . . .	1156
<b>13 Chapter L</b>	<b>1159</b>
13.1 package LAPLACE LaplaceTransform . . . . .	1159
13.1.1 LaplaceTransform (LAPLACE) . . . . .	1159
13.2 package LAZM3PK LazardSetSolvingPackage . . . . .	1164
13.2.1 LazardSetSolvingPackage (LAZM3PK) . . . . .	1184
13.3 package LEADCDET LeadingCoefDetermination . . . . .	1187
13.3.1 LeadingCoefDetermination (LEADCDET) . . . . .	1187
13.4 package LEXTRIPK LexTriangularPackage . . . . .	1190
13.4.1 LexTriangularPackage (LEXTRIPK) . . . . .	1259
13.5 package LINDEP LinearDependence . . . . .	1264
13.5.1 LinearDependence (LINDEP) . . . . .	1264
13.6 package LODOF LinearOrdinaryDifferentialOperatorFactorizer . . . . .	1266
13.6.1 LinearOrdinaryDifferentialOperatorFactorizer (LODOF) . . . . .	1266
13.7 package LODOOPS LinearOrdinaryDifferentialOperatorsOps . . . . .	1270
13.7.1 LinearOrdinaryDifferentialOperatorsOps (LODOOPS) . . . . .	1270
13.8 package LPEFRAC LinearPolynomialEquationByFractions . . . . .	1273
13.8.1 LinearPolynomialEquationByFractions (LPEFRAC) . . . . .	1273
13.9 package LISYSER LinearSystemFromPowerSeriesPackage . . . . .	1274
13.9.1 LinearSystemFromPowerSeriesPackage (LISYSER) . . . . .	1276
13.10package LSMP LinearSystemMatrixPackage . . . . .	1278
13.10.1 LinearSystemMatrixPackage (LSMP) . . . . .	1278
13.11package LSMP1 LinearSystemMatrixPackage1 . . . . .	1280
13.11.1 LinearSystemMatrixPackage1 (LSMP1) . . . . .	1280
13.12package LSPP LinearSystemPolynomialPackage . . . . .	1282
13.12.1 LinearSystemPolynomialPackage (LSPP) . . . . .	1282
13.13package LGROBP LinGroebnerPackage . . . . .	1284
13.13.1 LinGroebnerPackage (LGROBP) . . . . .	1284
13.14package LOP LinesOpPack . . . . .	1291
13.14.1 LinesOpPack (LOP) . . . . .	1292
13.15package LF LiouvillianFunction . . . . .	1295
13.15.1 LiouvillianFunction (LF) . . . . .	1295
13.16package LIST2 ListFunctions2 . . . . .	1300
13.16.1 ListFunctions2 (LIST2) . . . . .	1300
13.17package LIST3 ListFunctions3 . . . . .	1301
13.17.1 ListFunctions3 (LIST3) . . . . .	1301
13.18package LIST2MAP ListToMap . . . . .	1303
13.18.1 ListToMap (LIST2MAP) . . . . .	1303
13.19package LPARSPT LocalParametrizationOfSimplePointPackage . . . . .	1305
13.19.1 LocalParametrizationOfSimplePointPackage (LPARSPT) . . . . .	1306

<b>14 Chapter M</b>	<b>1313</b>
14.1 package MKBCFUNC MakeBinaryCompiledFunction . . . . .	1313
14.1.1 MakeBinaryCompiledFunction (MKBCFUNC) . . . . .	1313
14.2 package MKFLCFN MakeFloatCompiledFunction . . . . .	1315
14.2.1 MakeFloatCompiledFunction (MKFLCFN) . . . . .	1315
14.3 package MKFUNC MakeFunction . . . . .	1318
14.3.1 MakeFunction (MKFUNC) . . . . .	1322
14.4 package MKRECORD MakeRecord . . . . .	1324
14.4.1 MakeRecord (MKRECORD) . . . . .	1324
14.5 package MKUCFUNC MakeUnaryCompiledFunction . . . . .	1325
14.5.1 MakeUnaryCompiledFunction (MKUCFUNC) . . . . .	1325
14.6 package MAPHACK1 MappingPackageInternalHacks1 . . . . .	1326
14.6.1 MappingPackageInternalHacks1 (MAPHACK1) . . . . .	1326
14.7 package MAPHACK2 MappingPackageInternalHacks2 . . . . .	1328
14.7.1 MappingPackageInternalHacks2 (MAPHACK2) . . . . .	1328
14.8 package MAPHACK3 MappingPackageInternalHacks3 . . . . .	1329
14.8.1 MappingPackageInternalHacks3 (MAPHACK3) . . . . .	1329
14.9 package MAPPKG1 MappingPackage1 . . . . .	1330
14.9.1 MappingPackage1 (MAPPKG1) . . . . .	1339
14.10 package MAPPKG2 MappingPackage2 . . . . .	1341
14.10.1 MappingPackage2 (MAPPKG2) . . . . .	1350
14.11 package MAPPKG3 MappingPackage3 . . . . .	1351
14.11.1 MappingPackage3 (MAPPKG3) . . . . .	1360
14.12 package MAPPKG4 MappingPackage4 . . . . .	1362
14.12.1 MappingPackage4 (MAPPKG4) . . . . .	1367
14.13 package MATCAT2 MatrixCategoryFunctions2 . . . . .	1369
14.13.1 MatrixCategoryFunctions2 (MATCAT2) . . . . .	1369
14.14 package MCDEN MatrixCommonDenominator . . . . .	1371
14.14.1 MatrixCommonDenominator (MCDEN) . . . . .	1371
14.15 package MATLIN MatrixLinearAlgebraFunctions . . . . .	1373
14.15.1 MatrixLinearAlgebraFunctions (MATLIN) . . . . .	1373
14.16 package MTHING MergeThing . . . . .	1380
14.16.1 MergeThing (MTHING) . . . . .	1380
14.17 package MESH MeshCreationRoutinesForThreeDimensions . . . . .	1382
14.17.1 MeshCreationRoutinesForThreeDimensions (MESH) . . . . .	1382
14.18 package MDDFACT ModularDistinctDegreeFactorizer . . . . .	1385
14.18.1 ModularDistinctDegreeFactorizer (MDDFACT) . . . . .	1385
14.19 package MHROWRED ModularHermitianRowReduction . . . . .	1391
14.19.1 ModularHermitianRowReduction (MHROWRED) . . . . .	1391
14.20 package MRF2 MonoidRingFunctions2 . . . . .	1396
14.20.1 MonoidRingFunctions2 (MRF2) . . . . .	1396
14.21 package MONOTOOL MonomialExtensionTools . . . . .	1398
14.21.1 MonomialExtensionTools (MONOTOOL) . . . . .	1398
14.22 package MSYSCMD MoreSystemCommands . . . . .	1400
14.22.1 MoreSystemCommands (MSYSCMD) . . . . .	1400
14.23 package MPCPF MPolyCatPolyFactorizer . . . . .	1401

14.23.1 MPolyCatPolyFactorizer (MPCPF) . . . . .	1401
14.24package MPRFF MPolyCatRationalFunctionFactorizer . . . . .	1403
14.24.1 MPolyCatRationalFunctionFactorizer (MPRFF) . . . . .	1403
14.25package MPC2 MPolyCatFunctions2 . . . . .	1407
14.25.1 MPolyCatFunctions2 (MPC2) . . . . .	1407
14.26package MPC3 MPolyCatFunctions3 . . . . .	1408
14.26.1 MPolyCatFunctions3 (MPC3) . . . . .	1408
14.27package MRATFAC MRationalFactorize . . . . .	1410
14.27.1 MRationalFactorize (MRATFAC) . . . . .	1410
14.28package MFINFACT MultFiniteFactorize . . . . .	1412
14.28.1 MultFiniteFactorize (MFINFACT) . . . . .	1412
14.29package MMAP MultipleMap . . . . .	1422
14.29.1 MultipleMap (MMAP) . . . . .	1422
14.30package MCALCFN MultiVariableCalculusFunctions . . . . .	1424
14.30.1 MultiVariableCalculusFunctions (MCALCFN) . . . . .	1424
14.31package MULTFACT MultivariateFactorize . . . . .	1428
14.31.1 MultivariateFactorize (MULTFACT) . . . . .	1428
14.32package MLIFT MultivariateLifting . . . . .	1429
14.33package MULTSQFR MultivariateSquareFree . . . . .	1434
14.33.1 MultivariateSquareFree (MULTSQFR) . . . . .	1434

**15 Chapter N****1443**

15.1 package NAGF02 NagEigenPackage . . . . .	1443
15.1.1 NagEigenPackage (NAGF02) . . . . .	1509
15.2 package NAGE02 NagFittingPackage . . . . .	1521
15.2.1 NagFittingPackage (NAGE02) . . . . .	1650
15.3 package NAGF04 NagLinearEquationSolvingPackage . . . . .	1663
15.3.1 NagLinearEquationSolvingPackage (NAGF04) . . . . .	1729
15.4 package NAGSP NAGLinkSupportPackage . . . . .	1737
15.4.1 NAGLinkSupportPackage (NAGSP) . . . . .	1737
15.5 package NAGD01 NagIntegrationPackage . . . . .	1739
15.5.1 NagIntegrationPackage (NAGD01) . . . . .	1816
15.6 package NAGE01 NagInterpolationPackage . . . . .	1825
15.6.1 NagInterpolationPackage (NAGE01) . . . . .	1864
15.7 package NAGF07 NagLapack . . . . .	1871
15.7.1 NagLapack (NAGF07) . . . . .	1885
15.8 package NAGF01 NagMatrixOperationsPackage . . . . .	1888
15.8.1 NagMatrixOperationsPackage (NAGF01) . . . . .	1944
15.9 package NAGE04 NagOptimisationPackage . . . . .	1951
15.9.1 NagOptimisationPackage (NAGE04) . . . . .	2102
15.10package NAGD02 NagOrdinaryDifferentialEquationsPackage . . . . .	2111
15.10.1 NagOrdinaryDifferentialEquationsPackage (NAGD02) . . . . .	2201
15.11package NAGD03 NagPartialDifferentialEquationsPackage . . . . .	2211
15.11.1 NagPartialDifferentialEquationsPackage (NAGD03) . . . . .	2247
15.12package NAGC02 NagPolynomialRootsPackage . . . . .	2251
15.12.1 NagPolynomialRootsPackage (NAGC02) . . . . .	2265

15.13package NAGC05 NagRootFindingPackage . . . . .	2267
15.13.1 NagRootFindingPackage (NAGC05) . . . . .	2284
15.14package NAGC06 NagSeriesSummationPackage . . . . .	2287
15.14.1 NagSeriesSummationPackage (NAGC06) . . . . .	2331
15.15package NAGS NagSpecialFunctionsPackage . . . . .	2338
15.15.1 NagSpecialFunctionsPackage (NAGS) . . . . .	2484
15.16package NSUP2 NewSparseUnivariatePolynomialFunctions2 . . . . .	2500
15.16.1 NewSparseUnivariatePolynomialFunctions2 (NSUP2) . . . . .	2500
15.17package NEWTON NewtonInterpolation . . . . .	2502
15.17.1 NewtonInterpolation (NEWTON) . . . . .	2502
15.18package NPOLYGON NewtonPolygon . . . . .	2503
15.18.1 NewtonPolygon (NPOLYGON) . . . . .	2504
15.19package NCODIV NonCommutativeOperatorDivision . . . . .	2509
15.19.1 NonCommutativeOperatorDivision (NCODIV) . . . . .	2509
15.20package NONE1 NoneFunctions1 . . . . .	2512
15.20.1 NoneFunctions1 (NONE1) . . . . .	2512
15.21package NODE1 NonLinearFirstOrderODESolver . . . . .	2513
15.21.1 NonLinearFirstOrderODESolver (NODE1) . . . . .	2513
15.22package NLINSOL NonLinearSolvePackage . . . . .	2517
15.22.1 NonLinearSolvePackage (NLINSOL) . . . . .	2517
15.23package NORMPK NormalizationPackage . . . . .	2519
15.23.1 NormalizationPackage (NORMPK) . . . . .	2519
15.24package NORMMA NormInMonogenicAlgebra . . . . .	2524
15.24.1 NormInMonogenicAlgebra (NORMMA) . . . . .	2524
15.25package NORMRETR NormRetractPackage . . . . .	2526
15.25.1 NormRetractPackage (NORMRETR) . . . . .	2526
15.26package NPCOEF NPCoef . . . . .	2528
15.26.1 NPCoef (NPCOEF) . . . . .	2528
15.27package NFINTBAS NumberFieldIntegralBasis . . . . .	2532
15.27.1 NumberFieldIntegralBasis (NFINTBAS) . . . . .	2532
15.28package NUMFMT NumberFormats . . . . .	2537
15.28.1 NumberFormats (NUMFMT) . . . . .	2537
15.29package NTPOLFN NumberTheoreticPolynomialFunctions . . . . .	2542
15.29.1 NumberTheoreticPolynomialFunctions (NTPOLFN) . . . . .	2542
15.30package NUMERIC Numeric . . . . .	2544
15.30.1 Numeric (NUMERIC) . . . . .	2544
15.31package NUMODE NumericalOrdinaryDifferentialEquations . . . . .	2553
15.31.1 NumericalOrdinaryDifferentialEquations (NUMODE) . . . . .	2553
15.32package NUMQUAD NumericalQuadrature . . . . .	2561
15.32.1 NumericalQuadrature (NUMQUAD) . . . . .	2561
15.33package NCEP NumericComplexEigenPackage . . . . .	2573
15.33.1 NumericComplexEigenPackage (NCEP) . . . . .	2573
15.34package NCNTFRAC NumericContinuedFraction . . . . .	2575
15.34.1 NumericContinuedFraction (NCNTFRAC) . . . . .	2575
15.35package NREP NumericRealEigenPackage . . . . .	2577
15.35.1 NumericRealEigenPackage (NREP) . . . . .	2577

15.36package NUMTUBE NumericTubePlot . . . . .	2579
15.36.1 NumericTubePlot (NUMTUBE) . . . . .	2579

## 16 Chapter O 2583

16.1 package OCTCT2 OctonionCategoryFunctions2 . . . . .	2583
16.1.1 OctonionCategoryFunctions2 (OCTCT2) . . . . .	2583
16.2 package ODEINT ODEIntegration . . . . .	2585
16.2.1 ODEIntegration (ODEINT) . . . . .	2585
16.3 package ODETOOLS ODETools . . . . .	2587
16.3.1 ODETools (ODETOOLS) . . . . .	2587
16.4 package ARRAY12 OneDimensionalArrayFunctions2 . . . . .	2589
16.4.1 OneDimensionalArrayFunctions2 (ARRAY12) . . . . .	2589
16.5 package ONECOMP2 OnePointCompletionFunctions2 . . . . .	2591
16.5.1 OnePointCompletionFunctions2 (ONECOMP2) . . . . .	2591
16.6 package OMPKG OpenMathPackage . . . . .	2593
16.6.1 OpenMathPackage (OMPKG) . . . . .	2593
16.7 package OMSERVER OpenMathServerPackage . . . . .	2595
16.7.1 OpenMathServerPackage (OMSERVER) . . . . .	2595
16.8 package OPQUERY OperationsQuery . . . . .	2597
16.8.1 OperationsQuery (OPQUERY) . . . . .	2597
16.9 package ORDCOMP2 OrderedCompletionFunctions2 . . . . .	2598
16.9.1 OrderedCompletionFunctions2 (ORDCOMP2) . . . . .	2598
16.10package ORDFUNS OrderingFunctions . . . . .	2600
16.10.1 OrderingFunctions (ORDFUNS) . . . . .	2600
16.11package ORTHPOL OrthogonalPolynomialFunctions . . . . .	2602
16.11.1 OrthogonalPolynomialFunctions (ORTHPOL) . . . . .	2602
16.12package OUT OutputPackage . . . . .	2605
16.12.1 OutputPackage (OUT) . . . . .	2605

## 17 Chapter P 2607

17.1 package PAFF PackageForAlgebraicFunctionField . . . . .	2607
17.1.1 PackageForAlgebraicFunctionField (PAFF) . . . . .	2609
17.2 package PAFFFF PackageForAlgebraicFunctionFieldOverFiniteField . . . . .	2615
17.2.1 PackageForAlgebraicFunctionFieldOverFiniteField (PAFFFF) . . . . .	2617
17.3 package PFORP PackageForPoly . . . . .	2625
17.3.1 PackageForPoly (PFORP) . . . . .	2626
17.4 package PADEPAC PadeApproximantPackage . . . . .	2633
17.4.1 PadeApproximantPackage (PADEPAC) . . . . .	2633
17.5 package PADE PadeApproximants . . . . .	2635
17.5.1 PadeApproximants (PADE) . . . . .	2635
17.6 package PWFFINTB PAdicWildFunctionFieldIntegralBasis . . . . .	2638
17.6.1 PAdicWildFunctionFieldIntegralBasis (PWFFINTB) . . . . .	2638
17.7 package YSTREAM ParadoxicalCombinatorsForStreams . . . . .	2644
17.7.1 ParadoxicalCombinatorsForStreams (YSTREAM) . . . . .	2644
17.8 package PLEQN ParametricLinearEquations . . . . .	2646
17.8.1 ParametricLinearEquations (PLEQN) . . . . .	2646

17.9 package PARPC2 ParametricPlaneCurveFunctions2 . . . . .	2659
17.9.1 ParametricPlaneCurveFunctions2 (PARPC2) . . . . .	2659
17.10 package PARSC2 ParametricSpaceCurveFunctions2 . . . . .	2660
17.10.1 ParametricSpaceCurveFunctions2 (PARSC2) . . . . .	2660
17.11 package PARSU2 ParametricSurfaceFunctions2 . . . . .	2661
17.11.1 ParametricSurfaceFunctions2 (PARSU2) . . . . .	2661
17.12 package PARAMP ParametrizationPackage . . . . .	2662
17.12.1 ParametrizationPackage (PARAMP) . . . . .	2663
17.13 package PFRPAC PartialFractionPackage . . . . .	2665
17.13.1 PartialFractionPackage (PFRPAC) . . . . .	2667
17.14 package PARTPERM PartitionsAndPermutations . . . . .	2669
17.14.1 PartitionsAndPermutations (PARTPERM) . . . . .	2669
17.15 package PATTERN1 PatternFunctions1 . . . . .	2672
17.15.1 PatternFunctions1 (PATTERN1) . . . . .	2672
17.16 package PATTERN2 PatternFunctions2 . . . . .	2674
17.16.1 PatternFunctions2 (PATTERN2) . . . . .	2674
17.17 package PATMATCH PatternMatch . . . . .	2676
17.17.1 PatternMatch (PATMATCH) . . . . .	2676
17.18 package PMASS PatternMatchAssertions . . . . .	2678
17.18.1 PatternMatchAssertions (PMASS) . . . . .	2678
17.19 package PMFS PatternMatchFunctionSpace . . . . .	2680
17.19.1 PatternMatchFunctionSpace (PMFS) . . . . .	2680
17.20 package PMINS PatternMatchIntegerNumberSystem . . . . .	2682
17.20.1 PatternMatchIntegerNumberSystem (PMINS) . . . . .	2682
17.21 package INTPM PatternMatchIntegration . . . . .	2684
17.21.1 PatternMatchIntegration (INTPM) . . . . .	2684
17.22 package PMKERNEL PatternMatchKernel . . . . .	2691
17.22.1 PatternMatchKernel (PMKERNEL) . . . . .	2691
17.23 package PMLSAGG PatternMatchListAggregate . . . . .	2694
17.23.1 PatternMatchListAggregate (PMLSAGG) . . . . .	2694
17.24 package PMPLCAT PatternMatchPolynomialCategory . . . . .	2696
17.24.1 PatternMatchPolynomialCategory (PMPLCAT) . . . . .	2696
17.25 package PMDOWN PatternMatchPushDown . . . . .	2698
17.25.1 PatternMatchPushDown (PMDOWN) . . . . .	2698
17.26 package PMQFCAT PatternMatchQuotientFieldCategory . . . . .	2701
17.26.1 PatternMatchQuotientFieldCategory (PMQFCAT) . . . . .	2701
17.27 package PATRES2 PatternMatchResultFunctions2 . . . . .	2702
17.27.1 PatternMatchResultFunctions2 (PATRES2) . . . . .	2702
17.28 package PMSYM PatternMatchSymbol . . . . .	2704
17.28.1 PatternMatchSymbol (PMSYM) . . . . .	2704
17.29 package PMTOOLS PatternMatchTools . . . . .	2705
17.29.1 PatternMatchTools (PMTOOLS) . . . . .	2705
17.30 package PERMAN Permanent . . . . .	2709
17.30.1 Permanent (PERMAN) . . . . .	2711
17.31 package PGE PermutationGroupExamples . . . . .	2715
17.31.1 PermutationGroupExamples (PGE) . . . . .	2715

17.32package PICOERCE PiCoercions . . . . .	2723
17.32.1 PiCoercions (PICOERCE) . . . . .	2723
17.33package PLOT1 PlotFunctions1 . . . . .	2725
17.33.1 PlotFunctions1 (PLOT1) . . . . .	2725
17.34package PLOTTOOL PlotTools . . . . .	2726
17.34.1 PlotTools (PLOTTOOL) . . . . .	2726
17.35package PRJALGPK ProjectiveAlgebraicSetPackage . . . . .	2728
17.35.1 ProjectiveAlgebraicSetPackage (PRJALGPK) . . . . .	2730
17.36package PTFUNC2 PointFunctions2 . . . . .	2734
17.36.1 PointFunctions2 (PTFUNC2) . . . . .	2734
17.37package PTPACK PointPackage . . . . .	2735
17.37.1 PointPackage (PTPACK) . . . . .	2735
17.38package PFO PointsOfFiniteOrder . . . . .	2737
17.38.1 PointsOfFiniteOrder (PFO) . . . . .	2737
17.39package PFOQ PointsOfFiniteOrderRational . . . . .	2744
17.39.1 PointsOfFiniteOrderRational (PFOQ) . . . . .	2744
17.40package PFOTOOLS PointsOfFiniteOrderTools . . . . .	2746
17.40.1 PointsOfFiniteOrderTools (PFOTOOLS) . . . . .	2746
17.41package PLPKCRV PolynomialPackageForCurve . . . . .	2748
17.41.1 PolynomialPackageForCurve (PLPKCRV) . . . . .	2749
17.42package POLTOPOL PolToPol . . . . .	2751
17.42.1 PolToPol (POLTOPOL) . . . . .	2751
17.43package PGROEB PolyGroebner . . . . .	2754
17.43.1 PolyGroebner (PGROEB) . . . . .	2754
17.44package PAN2EXPR PolynomialAN2Expression . . . . .	2756
17.44.1 PolynomialAN2Expression (PAN2EXPR) . . . . .	2756
17.45package POLYLIFT PolynomialCategoryLifting . . . . .	2757
17.45.1 PolynomialCategoryLifting (POLYLIFT) . . . . .	2757
17.46package POLYCATQ PolynomialCategoryQuotientFunctions . . . . .	2759
17.46.1 PolynomialCategoryQuotientFunctions (POLYCATQ) . . . . .	2759
17.47package PCOMP PolynomialComposition . . . . .	2762
17.47.1 PolynomialComposition (PCOMP) . . . . .	2762
17.48package PDECOMP PolynomialDecomposition . . . . .	2763
17.48.1 PolynomialDecomposition (PDECOMP) . . . . .	2763
17.49package PFBR PolynomialFactorizationByRecursion . . . . .	2765
17.49.1 PolynomialFactorizationByRecursion (PFBR) . . . . .	2765
17.50package PFBRU PolynomialFactorizationByRecursionUnivariate . . . . .	2772
17.50.1 PolynomialFactorizationByRecursionUnivariate (PFBRU) . . . . .	2772
17.51package POLY2 PolynomialFunctions2 . . . . .	2777
17.51.1 PolynomialFunctions2 (POLY2) . . . . .	2777
17.52package PGCD PolynomialGcdPackage . . . . .	2779
17.52.1 PolynomialGcdPackage (PGCD) . . . . .	2779
17.53package PINTERP PolynomialInterpolation . . . . .	2787
17.53.1 PolynomialInterpolation (PINTERP) . . . . .	2787
17.54package PINTERPA PolynomialInterpolationAlgorithms . . . . .	2789
17.54.1 PolynomialInterpolationAlgorithms (PINTERPA) . . . . .	2789

17.55package PNTHEORY PolynomialNumberTheoryFunctions . . . . .	2790
17.55.1 PolynomialNumberTheoryFunctions (PNTHEORY) . . . . .	2790
17.56package POLYROOT PolynomialRoots . . . . .	2795
17.56.1 PolynomialRoots (POLYROOT) . . . . .	2795
17.57package PSETPK PolynomialSetUtilitiesPackage . . . . .	2798
17.57.1 PolynomialSetUtilitiesPackage (PSETPK) . . . . .	2798
17.58package SOLVEFOR PolynomialSolveByFormulas . . . . .	2816
17.58.1 PolynomialSolveByFormulas (SOLVEFOR) . . . . .	2816
17.59package PSQFR PolynomialSquareFree . . . . .	2822
17.59.1 PolynomialSquareFree (PSQFR) . . . . .	2822
17.60package POLY2UP PolynomialToUnivariatePolynomial . . . . .	2825
17.60.1 PolynomialToUnivariatePolynomial (POLY2UP) . . . . .	2825
17.61package LIMITPS PowerSeriesLimitPackage . . . . .	2827
17.61.1 PowerSeriesLimitPackage (LIMITPS) . . . . .	2827
17.62package PREASSOC PrecomputedAssociatedEquations . . . . .	2838
17.62.1 PrecomputedAssociatedEquations (PREASSOC) . . . . .	2838
17.63package PRIMARR2 PrimitiveArrayFunctions2 . . . . .	2841
17.63.1 PrimitiveArrayFunctions2 (PRIMARR2) . . . . .	2841
17.64package PRIMELT PrimitiveElement . . . . .	2843
17.64.1 PrimitiveElement (PRIMELT) . . . . .	2843
17.65package ODEPRIM PrimitiveRatDE . . . . .	2846
17.65.1 PrimitiveRatDE (ODEPRIM) . . . . .	2846
17.66package ODEPRRIC PrimitiveRatRicDE . . . . .	2850
17.66.1 PrimitiveRatRicDE (ODEPRRIC) . . . . .	2850
17.67package PRINT PrintPackage . . . . .	2856
17.67.1 PrintPackage (PRINT) . . . . .	2856
17.68package PSEUDLIN PseudoLinearNormalForm . . . . .	2857
17.68.1 PseudoLinearNormalForm (PSEUDLIN) . . . . .	2857
17.69package PRS PseudoRemainderSequence . . . . .	2861
17.69.1 PseudoRemainderSequence (PRS) . . . . .	2861
17.70package INTPAF PureAlgebraicIntegration . . . . .	2880
17.70.1 PureAlgebraicIntegration (INTPAF) . . . . .	2880
17.71package ODEPAL PureAlgebraicLODE . . . . .	2889
17.71.1 PureAlgebraicLODE (ODEPAL) . . . . .	2889
17.72package PUSHVAR PushVariables . . . . .	2890
17.72.1 PushVariables (PUSHVAR) . . . . .	2890
<b>18 Chapter Q</b>	<b>2893</b>
18.1 package QALGSET2 QuasiAlgebraicSet2 . . . . .	2893
18.1.1 QuasiAlgebraicSet2 (QALGSET2) . . . . .	2893
18.2 package QCMPACK QuasiComponentPackage . . . . .	2896
18.2.1 QuasiComponentPackage (QCMPACK) . . . . .	2896
18.3 package QFCAT2 QuotientFieldCategoryFunctions2 . . . . .	2905
18.3.1 QuotientFieldCategoryFunctions2 (QFCAT2) . . . . .	2905
18.4 package QUATCT2 QuaternionCategoryFunctions2 . . . . .	2906
18.4.1 QuaternionCategoryFunctions2 (QUATCT2) . . . . .	2908



<b>19 Chapter R</b>	<b>2911</b>
19.1 package REP RadicalEigenPackage . . . . .	2911
19.1.1 RadicalEigenPackage (REP) . . . . .	2911
19.2 package SOLVERAD RadicalSolvePackage . . . . .	2915
19.2.1 RadicalSolvePackage (SOLVERAD) . . . . .	2925
19.3 package RADUTIL RadixUtilities . . . . .	2932
19.3.1 RadixUtilities (RADUTIL) . . . . .	2932
19.4 package RDIST RandomDistributions . . . . .	2933
19.4.1 RandomDistributions (RDIST) . . . . .	2933
19.5 package RFDIST RandomFloatDistributions . . . . .	2935
19.5.1 RandomFloatDistributions (RFDIST) . . . . .	2935
19.6 package RIDIST RandomIntegerDistributions . . . . .	2937
19.6.1 RandomIntegerDistributions (RIDIST) . . . . .	2937
19.7 package RANDSRC RandomNumberSource . . . . .	2939
19.7.1 RandomNumberSource (RANDSRC) . . . . .	2939
19.8 package RATFACT RationalFactorize . . . . .	2941
19.8.1 RationalFactorize (RATFACT) . . . . .	2941
19.9 package RF RationalFunction . . . . .	2943
19.9.1 RationalFunction (RF) . . . . .	2943
19.10 package DEFINTRF RationalFunctionDefiniteIntegration . . . . .	2945
19.10.1 RationalFunctionDefiniteIntegration (DEFINTRF) . . . . .	2945
19.11 package RFFACT RationalFunctionFactor . . . . .	2948
19.11.1 RationalFunctionFactor (RFFACT) . . . . .	2948
19.12 package RFFACTOR RationalFunctionFactorizer . . . . .	2949
19.12.1 RationalFunctionFactorizer (RFFACTOR) . . . . .	2949
19.13 package INTRF RationalFunctionIntegration . . . . .	2951
19.13.1 RationalFunctionIntegration (INTRF) . . . . .	2951
19.14 package LIMITRF RationalFunctionLimitPackage . . . . .	2953
19.14.1 RationalFunctionLimitPackage (LIMITRF) . . . . .	2953
19.15 package SIGNRF RationalFunctionSign . . . . .	2957
19.15.1 RationalFunctionSign (SIGNRF) . . . . .	2957
19.16 package SUMRF RationalFunctionSum . . . . .	2959
19.16.1 RationalFunctionSum (SUMRF) . . . . .	2965
19.17 package INTRAT RationalIntegration . . . . .	2967
19.17.1 RationalIntegration (INTRAT) . . . . .	2967
19.18 package RINTERP RationalInterpolation . . . . .	2969
19.18.1 Introduction . . . . .	2969
19.18.2 Questions and Outlook . . . . .	2969
19.18.3 RationalInterpolation (RINTERP) . . . . .	2969
19.19 package ODERAT RationalLODE . . . . .	2972
19.19.1 RationalLODE (ODERAT) . . . . .	2972
19.20 package RATRET RationalRetractions . . . . .	2977
19.20.1 RationalRetractions (RATRET) . . . . .	2977
19.21 package ODERTRIC RationalRicDE . . . . .	2979
19.21.1 RationalRicDE (ODERTRIC) . . . . .	2979
19.22 package RURPK RationalUnivariateRepresentationPackage . . . . .	2985

19.22.1 RationalUnivariateRepresentationPackage (RURPK) . . . . .	2985
19.23package POLUTIL RealPolynomialUtilitiesPackage . . . . .	2988
19.23.1 RealPolynomialUtilitiesPackage (POLUTIL) . . . . .	2989
19.24package REALSOLV RealSolvePackage . . . . .	2992
19.24.1 RealSolvePackage (REALSOLV) . . . . .	2996
19.25package REAL0 RealZeroPackage . . . . .	2998
19.25.1 RealZeroPackage (REAL0) . . . . .	2998
19.26package REAL0Q RealZeroPackageQ . . . . .	3004
19.26.1 RealZeroPackageQ (REAL0Q) . . . . .	3004
19.27package RMCAT2 RectangularMatrixCategoryFunctions2 . . . . .	3007
19.27.1 RectangularMatrixCategoryFunctions2 (RMCAT2) . . . . .	3007
19.28package RECOP RecurrenceOperator . . . . .	3009
19.28.1 RecurrenceOperator (RECOP) . . . . .	3009
19.28.2 Defining new operators . . . . .	3010
19.28.3 Recurrences . . . . .	3012
19.28.4 Functional Equations . . . . .	3016
19.29package RDIV ReducedDivisor . . . . .	3020
19.29.1 ReducedDivisor (RDIV) . . . . .	3020
19.30package ODERED ReduceLODE . . . . .	3022
19.30.1 ReduceLODE (ODERED) . . . . .	3022
19.31package REDORDER ReductionOfOrder . . . . .	3024
19.31.1 ReductionOfOrder (REDORDER) . . . . .	3024
19.32package RSDCMPK RegularSetDecompositionPackage . . . . .	3026
19.32.1 RegularSetDecompositionPackage (RSDCMPK) . . . . .	3026
19.33package RSETGCD RegularTriangularSetGcdPackage . . . . .	3032
19.33.1 RegularTriangularSetGcdPackage (RSETGCD) . . . . .	3032
19.34package REPDB RepeatedDoubling . . . . .	3040
19.34.1 RepeatedDoubling (REPDB) . . . . .	3040
19.35package REPSQ RepeatedSquaring . . . . .	3041
19.35.1 RepeatedSquaring (REPSQ) . . . . .	3042
19.36package REP1 RepresentationPackage1 . . . . .	3043
19.36.1 RepresentationPackage1 (REP1) . . . . .	3043
19.37package REP2 RepresentationPackage2 . . . . .	3050
19.37.1 RepresentationPackage2 (REP2) . . . . .	3050
19.38package RESLATC ResolveLatticeCompletion . . . . .	3067
19.38.1 ResolveLatticeCompletion (RESLATC) . . . . .	3067
19.39package RETSOL RetractSolvePackage . . . . .	3068
19.39.1 RetractSolvePackage (RETSOL) . . . . .	3068
19.40package RFP RootsFindingPackage . . . . .	3070
19.40.1 RootsFindingPackage (RFP) . . . . .	3071
<b>20 Chapter S</b>	<b>3075</b>
20.1 package SAERFFC SAERationalFunctionAlgFactor . . . . .	3075
20.1.1 SAERationalFunctionAlgFactor (SAERFFC) . . . . .	3075
20.2 package FORMULA1 ScriptFormulaFormat1 . . . . .	3076
20.2.1 ScriptFormulaFormat1 (FORMULA1) . . . . .	3076

20.3 package SEGBIND2 SegmentBindingFunctions2 . . . . .	3078
20.3.1 SegmentBindingFunctions2 (SEGBIND2) . . . . .	3078
20.4 package SEG2 SegmentFunctions2 . . . . .	3079
20.4.1 SegmentFunctions2 (SEG2) . . . . .	3079
20.5 package SAEFACT SimpleAlgebraicExtensionAlgFactor . . . . .	3081
20.5.1 SimpleAlgebraicExtensionAlgFactor (SAEFACT) . . . . .	3081
20.6 package SIMPAN SimplifyAlgebraicNumberConvertPackage . . . . .	3082
20.6.1 SimplifyAlgebraicNumberConvertPackage (SIMPAN) . . . . .	3082
20.7 package SMITH SmithNormalForm . . . . .	3083
20.7.1 SmithNormalForm (SMITH) . . . . .	3083
20.8 package SCACHE SortedCache . . . . .	3088
20.8.1 SortedCache (SCACHE) . . . . .	3088
20.9 package SORTPAK SortPackage . . . . .	3091
20.9.1 SortPackage (SORTPAK) . . . . .	3091
20.10 package SUP2 SparseUnivariatePolynomialFunctions2 . . . . .	3093
20.10.1 SparseUnivariatePolynomialFunctions2 (SUP2) . . . . .	3093
20.11 package SPECOUT SpecialOutputPackage . . . . .	3094
20.11.1 SpecialOutputPackage (SPECOUT) . . . . .	3094
20.12 package SFQCMPPK SquareFreeQuasiComponentPackage . . . . .	3096
20.12.1 SquareFreeQuasiComponentPackage (SFQCMPPK) . . . . .	3096
20.13 package SRDCMPK SquareFreeRegularSetDecompositionPackage . . . . .	3106
20.13.1 SquareFreeRegularSetDecompositionPackage (SRDCMPK) . . . . .	3106
20.14 package SFRGCD SquareFreeRegularTriangularSetGcdPackage . . . . .	3112
20.14.1 SquareFreeRegularTriangularSetGcdPackage (SFRGCD) . . . . .	3112
20.15 package MATSTOR StorageEfficientMatrixOperations . . . . .	3122
20.15.1 StorageEfficientMatrixOperations (MATSTOR) . . . . .	3122
20.16 package STREAM1 StreamFunctions1 . . . . .	3127
20.16.1 StreamFunctions1 (STREAM1) . . . . .	3127
20.17 package STREAM2 StreamFunctions2 . . . . .	3128
20.17.1 StreamFunctions2 (STREAM2) . . . . .	3128
20.18 package STREAM3 StreamFunctions3 . . . . .	3130
20.18.1 StreamFunctions3 (STREAM3) . . . . .	3130
20.19 package STINPROD StreamInfiniteProduct . . . . .	3132
20.19.1 StreamInfiniteProduct (STINPROD) . . . . .	3132
20.20 package STTAYLOR StreamTaylorSeriesOperations . . . . .	3134
20.20.1 StreamTaylorSeriesOperations (STTAYLOR) . . . . .	3134
20.21 package STNSR StreamTensor . . . . .	3144
20.21.1 StreamTensor (STNSR) . . . . .	3145
20.22 package STTF StreamTranscendentalFunctions . . . . .	3146
20.22.1 StreamTranscendentalFunctions (STTF) . . . . .	3146
20.23 package STTFNC StreamTranscendentalFunctionsNonCommutative . . . . .	3156
20.23.1 StreamTranscendentalFunctionsNonCommutative (STTFNC) . . . . .	3156
20.24 package SCPKG StructuralConstantsPackage . . . . .	3161
20.24.1 StructuralConstantsPackage (SCPKG) . . . . .	3161
20.25 package SHP SturmHabichtPackage . . . . .	3165
20.25.1 SturmHabichtPackage (SHP) . . . . .	3165

20.26package SUBRESP SubResultantPackage . . . . .	3173
20.26.1 SubResultantPackage (SUBRESP) . . . . .	3173
20.27package SUPFRACF SupFractionFactorizer . . . . .	3176
20.27.1 SupFractionFactorizer (SUPFRACF) . . . . .	3176
20.28package ODESYS SystemODESolver . . . . .	3178
20.28.1 SystemODESolver (ODESYS) . . . . .	3178
20.29package SYSSOLP SystemSolvePackage . . . . .	3184
20.29.1 SystemSolvePackage (SYSSOLP) . . . . .	3184
20.30package SGCF SymmetricGroupCombinatoricFunctions . . . . .	3189
20.30.1 SymmetricGroupCombinatoricFunctions (SGCF) . . . . .	3189
20.31package SYMFUNC SymmetricFunctions . . . . .	3200
20.31.1 SymmetricFunctions (SYMFUNC) . . . . .	3200
<b>21 Chapter T</b>	<b>3203</b>
21.1 package TABLBUMP TableauxBumpers . . . . .	3203
21.1.1 TableauxBumpers (TABLBUMP) . . . . .	3203
21.2 package TBCMPPK TabulatedComputationPackage . . . . .	3206
21.2.1 TabulatedComputationPackage (TBCMPPK) . . . . .	3206
21.3 package TANEXP TangentExpansions . . . . .	3210
21.3.1 TangentExpansions (TANEXP) . . . . .	3210
21.4 package UTSSOL TaylorSolve . . . . .	3211
21.4.1 TaylorSolve (UTSSOL) . . . . .	3212
21.5 package TEMUTL TemplateUtilities . . . . .	3215
21.5.1 TemplateUtilities (TEMUTL) . . . . .	3215
21.6 package TEX1 TexFormat1 . . . . .	3217
21.6.1 TexFormat1 (TEX1) . . . . .	3217
21.7 package TOOLSIGN ToolsForSign . . . . .	3218
21.7.1 ToolsForSign (TOOLSIGN) . . . . .	3218
21.8 package DRAW TopLevelDrawFunctions . . . . .	3220
21.8.1 TopLevelDrawFunctions (DRAW) . . . . .	3220
21.9 package DRAWCURV TopLevelDrawFunctionsForAlgebraicCurves . . . . .	3227
21.9.1 TopLevelDrawFunctionsForAlgebraicCurves (DRAWCURV) . . . . .	3227
21.10package DRAWCFUN TopLevelDrawFunctionsForCompiledFunctions . . . . .	3231
21.10.1 TopLevelDrawFunctionsForCompiledFunctions (DRAWCFUN) . . . . .	3231
21.11package DRAWPT TopLevelDrawFunctionsForPoints . . . . .	3244
21.11.1 TopLevelDrawFunctionsForPoints (DRAWPT) . . . . .	3244
21.12package TOPSP TopLevelThreeSpace . . . . .	3247
21.12.1 TopLevelThreeSpace (TOPSP) . . . . .	3247
21.13package INTHERTR TranscendentalHermiteIntegration . . . . .	3248
21.13.1 TranscendentalHermiteIntegration (INTHERTR) . . . . .	3248
21.14package INTTR TranscendentalIntegration . . . . .	3250
21.14.1 TranscendentalIntegration (INTTR) . . . . .	3250
21.15package TRMANIP TranscendentalManipulations . . . . .	3260
21.15.1 TranscendentalManipulations (TRMANIP) . . . . .	3260
21.16package RDETR TranscendentalRischDE . . . . .	3269
21.16.1 TranscendentalRischDE (RDETR) . . . . .	3269

21.17package RDETRS TranscendentalRischDESystem . . . . .	3273
21.17.1 TranscendentalRischDESystem (RDETRS) . . . . .	3273
21.18package SOLVETRA TransSolvePackage . . . . .	3278
21.18.1 TransSolvePackage (SOLVETRA) . . . . .	3284
21.19package SOLVESER TransSolvePackageService . . . . .	3295
21.19.1 TransSolvePackageService (SOLVESER) . . . . .	3295
21.20package TRIMAT TriangularMatrixOperations . . . . .	3298
21.20.1 TriangularMatrixOperations (TRIMAT) . . . . .	3298
21.21package TRIGMNIP TrigonometricManipulations . . . . .	3300
21.21.1 TrigonometricManipulations (TRIGMNIP) . . . . .	3300
21.22package TUBETOOL TubePlotTools . . . . .	3304
21.22.1 TubePlotTools (TUBETOOL) . . . . .	3304
21.23package CLIP TwoDimensionalPlotClipping . . . . .	3307
21.23.1 TwoDimensionalPlotClipping (CLIP) . . . . .	3307
21.24package TWOFACT TwoFactorize . . . . .	3313
21.24.1 TwoFactorize (TWOFACT) . . . . .	3313
<b>22 Chapter U</b>	<b>3319</b>
22.1 package UNIFACT UnivariateFactorize . . . . .	3319
22.1.1 UnivariateFactorize (UNIFACT) . . . . .	3319
22.2 package UFPS1 UnivariateFormalPowerSeriesFunctions . . . . .	3326
22.2.1 UnivariateFormalPowerSeriesFunctions (UFPS1) . . . . .	3326
22.3 package ULS2 UnivariateLaurentSeriesFunctions2 . . . . .	3327
22.3.1 UnivariateLaurentSeriesFunctions2 (ULS2) . . . . .	3327
22.4 package UPOLYC2 UnivariatePolynomialCategoryFunctions2 . . . . .	3329
22.4.1 UnivariatePolynomialCategoryFunctions2 (UPOLYC2) . . . . .	3329
22.5 package UPCDEN UnivariatePolynomialCommonDenominator . . . . .	3330
22.5.1 UnivariatePolynomialCommonDenominator (UPCDEN) . . . . .	3330
22.6 package UPDECOMP UnivariatePolynomialDecompositionPackage . . . . .	3332
22.6.1 UnivariatePolynomialDecompositionPackage (UPDECOMP) . . . . .	3332
22.7 package UPDIVP UnivariatePolynomialDivisionPackage . . . . .	3335
22.7.1 UnivariatePolynomialDivisionPackage (UPDIVP) . . . . .	3335
22.8 package UP2 UnivariatePolynomialFunctions2 . . . . .	3337
22.8.1 UnivariatePolynomialFunctions2 (UP2) . . . . .	3337
22.9 package UPMP UnivariatePolynomialMultiplicationPackage . . . . .	3338
22.9.1 UnivariatePolynomialMultiplicationPackage (UPMP) . . . . .	3338
22.10package UPSQFREE UnivariatePolynomialSquareFree . . . . .	3341
22.10.1 UnivariatePolynomialSquareFree (UPSQFREE) . . . . .	3341
22.11package UPXS2 UnivariatePuisseuxSeriesFunctions2 . . . . .	3344
22.11.1 UnivariatePuisseuxSeriesFunctions2 (UPXS2) . . . . .	3344
22.12package OREPCTO UnivariateSkewPolynomialCategoryOps . . . . .	3345
22.12.1 UnivariateSkewPolynomialCategoryOps (OREPCTO) . . . . .	3345
22.13package UTS2 UnivariateTaylorSeriesFunctions2 . . . . .	3349
22.13.1 UnivariateTaylorSeriesFunctions2 (UTS2) . . . . .	3349
22.14package UTSODE UnivariateTaylorSeriesODESolver . . . . .	3350
22.14.1 UnivariateTaylorSeriesODESolver (UTSODE) . . . . .	3350

22.15package UNISEG2 UniversalSegmentFunctions2 . . . . .	3353
22.15.1 UniversalSegmentFunctions2 (UNISEG2) . . . . .	3353
22.16package UDPO UserDefinedPartialOrdering . . . . .	3355
22.16.1 UserDefinedPartialOrdering (UDPO) . . . . .	3355
22.17package UDVO UserDefinedVariableOrdering . . . . .	3357
22.17.1 UserDefinedVariableOrdering (UDVO) . . . . .	3357
22.18package UTSODETL UTSodetools . . . . .	3359
22.18.1 UTSodetools (UTSODETL) . . . . .	3359
<b>23 Chapter V</b>	<b>3361</b>
23.1 package VECTOR2 VectorFunctions2 . . . . .	3361
23.1.1 VectorFunctions2 (VECTOR2) . . . . .	3361
23.2 package VIEWDEF ViewDefaultsPackage . . . . .	3363
23.2.1 ViewDefaultsPackage (VIEWDEF) . . . . .	3363
23.3 package VIEW ViewportPackage . . . . .	3368
23.3.1 ViewportPackage (VIEW) . . . . .	3368
<b>24 Chapter W</b>	<b>3371</b>
24.1 package WEIER WeierstrassPreparation . . . . .	3371
24.1.1 WeierstrassPreparation (WEIER) . . . . .	3371
24.2 package WFFINTBS WildFunctionFieldIntegralBasis . . . . .	3375
24.2.1 WildFunctionFieldIntegralBasis (WFFINTBS) . . . . .	3375
<b>25 Chapter X</b>	<b>3381</b>
25.1 package XEXPPKG XExponentialPackage . . . . .	3381
25.1.1 XExponentialPackage (XEXPPKG) . . . . .	3381
<b>26 Chapter Y</b>	<b>3385</b>
<b>27 Chapter Z</b>	<b>3387</b>
27.1 package ZDSOLVE ZeroDimensionalSolvePackage . . . . .	3387
27.1.1 ZeroDimensionalSolvePackage (ZDSOLVE) . . . . .	3450
<b>28 Chunk collections</b>	<b>3461</b>
<b>29 Index</b>	<b>3473</b>

## Volume 10.5: Axiom Algebra: Numerics

<b>1</b>	<b>Numerical Analysis [?]</b>	<b>1</b>
<b>2</b>	<b>Chapter Overview</b>	<b>3</b>
<b>3</b>	<b>Algebra Cover Code</b>	<b>5</b>
3.1	package BLAS1 BlasLevelOne . . . . .	5
3.1.1	BlasLevelOne (BLAS1) . . . . .	8
3.2	dcabs1 BLAS . . . . .	10
3.3	lsame BLAS . . . . .	14
3.4	xerbla BLAS . . . . .	14
<b>4</b>	<b>BLAS Level 1</b>	<b>15</b>
4.1	dasum BLAS . . . . .	15
4.2	daxpy BLAS . . . . .	24
4.3	dcopy BLAS . . . . .	32
4.4	ddot BLAS . . . . .	38
4.5	dnrm2 BLAS . . . . .	42
4.6	drotg BLAS . . . . .	45
4.7	drot BLAS . . . . .	48
4.8	dscal BLAS . . . . .	51
4.9	dswap BLAS . . . . .	55
4.10	dzasum BLAS . . . . .	58
4.11	dznrm2 BLAS . . . . .	61
4.12	icamax BLAS . . . . .	64
4.13	idamax BLAS . . . . .	66
4.14	isamax BLAS . . . . .	69
4.15	izamax BLAS . . . . .	72
4.16	zaxpy BLAS . . . . .	75
4.17	zcopy BLAS . . . . .	78
4.18	zdotc BLAS . . . . .	81
4.19	zdotu BLAS . . . . .	84
4.20	zdscal BLAS . . . . .	87
4.21	zrotg BLAS . . . . .	89
4.22	zscal BLAS . . . . .	92
4.23	zswap BLAS . . . . .	94
<b>5</b>	<b>BLAS Level 2</b>	<b>99</b>
5.1	dgbmv BLAS . . . . .	99
5.2	dgemv BLAS . . . . .	107
5.3	dger BLAS . . . . .	115
5.4	dsbmv BLAS . . . . .	119
5.5	dspmv BLAS . . . . .	128
5.6	dspr2 BLAS . . . . .	137
5.7	dspr BLAS . . . . .	144

5.8	dsymv BLAS	151
5.9	dsyr2 BLAS	159
5.10	dsyr BLAS	166
5.11	dtbmv BLAS	172
5.12	dtbsv BLAS	184
5.13	dtpmv BLAS	196
5.14	dtpsv BLAS	208
5.15	dtrmv BLAS	219
5.16	dtrsv BLAS	229
5.17	zgbmv BLAS	240
5.18	zgemv BLAS	249
5.19	zgerc BLAS	257
5.20	zgeru BLAS	262
5.21	zhbmv BLAS	266
5.22	zhemv BLAS	275
5.23	zher2 BLAS	284
5.24	zher BLAS	295
5.25	zhpmv BLAS	303
5.26	zhpr2 BLAS	312
5.27	zhpr BLAS	327
5.28	ztbmv BLAS	336
5.29	ztbsv BLAS	351
5.30	ztpmv BLAS	366
5.31	ztpsv BLAS	380
5.32	ztrmv BLAS	394
5.33	ztrsv BLAS	407
<b>6</b>	<b>BLAS Level 3</b>	<b>421</b>
6.1	dgemm BLAS	421
6.2	dsymm BLAS	430
6.3	dsyr2k BLAS	440
6.4	dsyrk BLAS	451
6.5	dtrmm BLAS	460
6.6	dtrsm BLAS	473
6.7	zgemm BLAS	487
6.8	zhemm BLAS	501
6.9	zher2k BLAS	512
6.10	zherk BLAS	527
6.11	zsymm BLAS	540
6.12	zsyr2k BLAS	551
6.13	zsyrk BLAS	561
6.14	ztrmm BLAS	570
6.15	ztrsm BLAS	585



<b>7 LAPACK</b>	<b>603</b>
7.1 dbdsdc LAPACK	603
7.2 dbdsqr LAPACK	616
7.3 ddisna LAPACK	642
7.4 dgebak LAPACK	647
7.5 dgebal LAPACK	651
7.6 dgebd2 LAPACK	658
7.7 dgebrd LAPACK	666
7.8 dgeev LAPACK	672
7.9 dgeevx LAPACK	686
7.10 dgehd2 LAPACK	703
7.11 dgehrd LAPACK	707
7.12 dgelq2 LAPACK	713
7.13 dgelqf LAPACK	716
7.14 dgeqr2 LAPACK	721
7.15 dgeqrf LAPACK	724
7.16 dgesdd LAPACK	728
7.17 dgesvd LAPACK	772
7.18 dgesv LAPACK	903
7.19 dgetf2 LAPACK	905
7.20 dgetrf LAPACK	909
7.21 dgetrs LAPACK	913
7.22 dhseqr LAPACK	916
7.23 dlabad LAPACK	929
7.24 dlabrd LAPACK	931
7.25 dlacon LAPACK	944
7.26 dlacpy LAPACK	949
7.27 dladiv LAPACK	952
7.28 dlaed6 LAPACK	953
7.29 dlaexc LAPACK	962
7.30 dlahqr LAPACK	973
7.31 dlahrd LAPACK	989
7.32 dlaln2 LAPACK	995
7.33 dlamch LAPACK	1012
7.34 dlamc1 LAPACK	1015
7.35 dlamc2 LAPACK	1020
7.36 dlamc3 LAPACK	1026
7.37 dlamc4 LAPACK	1028
7.38 dlamc5 LAPACK	1030
7.39 dlamrg LAPACK	1033
7.40 dlange LAPACK	1036
7.41 dlanhs LAPACK	1040
7.42 dlanst LAPACK	1044
7.43 dlanv2 LAPACK	1048
7.44 dlapy2 LAPACK	1052
7.45 dlaqtr LAPACK	1053

7.46	dlarfb LAPACK	1079
7.47	dlarfg LAPACK	1093
7.48	dlarf LAPACK	1096
7.49	dlarft LAPACK	1098
7.50	dlarfx LAPACK	1105
7.51	dlartg LAPACK	1148
7.52	das2 LAPACK	1151
7.53	dascl LAPACK	1154
7.54	dasd0 LAPACK	1161
7.55	dasd1 LAPACK	1168
7.56	dasd2 LAPACK	1174
7.57	dasd3 LAPACK	1187
7.58	dasd4 LAPACK	1200
7.59	dasd5 LAPACK	1233
7.60	dasd6 LAPACK	1239
7.61	dasd7 LAPACK	1246
7.62	dasd8 LAPACK	1258
7.63	dasda LAPACK	1267
7.64	dasdq LAPACK	1281
7.65	dasdt LAPACK	1289
7.66	daset LAPACK	1293
7.67	dasq1 LAPACK	1296
7.68	dasq2 LAPACK	1300
7.69	dasq3 LAPACK	1319
7.70	dasq4 LAPACK	1333
7.71	dasq5 LAPACK	1346
7.72	dasq6 LAPACK	1356
7.73	dasr LAPACK	1365
7.74	dasrt LAPACK	1379
7.75	dasq LAPACK	1385
7.76	dasv2 LAPACK	1388
7.77	daswp LAPACK	1392
7.78	das2 LAPACK	1396
7.79	dorg2r LAPACK	1412
7.80	dorgbr LAPACK	1415
7.81	dorghr LAPACK	1422
7.82	dorgl2 LAPACK	1426
7.83	dorglq LAPACK	1429
7.84	dorgqr LAPACK	1435
7.85	dorm2r LAPACK	1440
7.86	dormbr LAPACK	1444
7.87	dorml2 LAPACK	1450
7.88	dormlq LAPACK	1454
7.89	dormqr LAPACK	1460
7.90	dtrevc LAPACK	1466
7.91	dtrexcl LAPACK	1508

7.92	dtrsna LAPACK . . . . .	1517
7.93	ieeck LAPACK . . . . .	1533
7.94	ilaenv LAPACK . . . . .	1536
7.95	zlange LAPACK . . . . .	1548
7.96	zlassq LAPACK . . . . .	1552
<b>8</b>	<b>Chunk collections</b>	<b>1555</b>
<b>9</b>	<b>Index</b>	<b>1563</b>

## Volume 11: Axiom Browser

<b>1</b>	<b>Overview</b>	<b>1</b>
1.1	Build Instructions . . . . .	1
1.2	The Makefile . . . . .	2
1.3	Building new pages . . . . .	3
1.3.1	Communicating with Axiom . . . . .	3
1.3.2	Handling statements with no free variables . . . . .	4
1.3.3	Handling statements with free variables . . . . .	4
1.3.4	Handling domain database lookups . . . . .	4
1.3.5	Handling )show domain . . . . .	4
1.3.6	Handling lisp expressions . . . . .	5
1.3.7	Handling expressions that have no output . . . . .	5
1.4	Defined Pages . . . . .	5
1.5	The Standard Layout . . . . .	19
1.6	Cascading Style Sheet . . . . .	20
1.6.1	Standard Style Sheet . . . . .	20
1.6.2	Menu style sheet . . . . .	22
1.7	standard head . . . . .	26
1.8	Javascript functions . . . . .	27
1.8.1	Show only mathml . . . . .	27
1.8.2	Show Full Answer . . . . .	28
1.8.3	Handle Free Variables . . . . .	29
1.8.4	axiom talker . . . . .	31
1.9	Pages . . . . .	33
1.9.1	axiomfonts.xhtml . . . . .	48
1.9.2	aldorusersguidepage.xhtml . . . . .	99
1.9.3	algebrapage.xhtml . . . . .	99
1.9.4	algrouptheory.xhtml . . . . .	100
1.9.5	algrouptheorygroup.xhtml . . . . .	101
1.9.6	algrouptheoryrepa6.xhtml . . . . .	102
1.9.7	algrouptheoryrepththeory.xhtml . . . . .	106
1.9.8	alnumbertheory.xhtml . . . . .	107
1.9.9	alnumbertheorygalois.xhtml . . . . .	108
1.9.10	basiccommand.xhtml . . . . .	116
1.9.11	basiclimit.xhtml . . . . .	117
1.9.12	bcexpand.xhtml . . . . .	118
1.9.13	bcmatrix.xhtml . . . . .	120
1.9.14	calculus.xhtml . . . . .	125
1.9.15	calculuspage.xhtml . . . . .	126
1.9.16	calderivatives.xhtml . . . . .	128
1.9.17	calintegrals.xhtml . . . . .	131
1.9.18	callaplace.xhtml . . . . .	135
1.9.19	callimits.xhtml . . . . .	137
1.9.20	calmoreintegrals.xhtml . . . . .	141

1.9.21	calseries.xhtml	145
1.9.22	calseries1.xhtml	147
1.9.23	calseries2.xhtml	150
1.9.24	calseries3.xhtml	152
1.9.25	calseries4.xhtml	154
1.9.26	calseries5.xhtml	158
1.9.27	calseries6.xhtml	161
1.9.28	calseries7.xhtml	164
1.9.29	calseries8.xhtml	165
1.9.30	cats.xhtml	169
1.9.31	commandline.xhtml	170
1.9.32	complexlimit.xhtml	187
1.9.33	conversionfunctions.xhtml	189
1.9.34	cryptopage.xhtml	193
1.9.35	cryptoclass1.xhtml	195
1.9.36	cryptoclass2.xhtml	200
1.9.37	cryptoclass3.xhtml	204
1.9.38	cryptoclass4.xhtml	208
1.9.39	cryptoclass5.xhtml	212
1.9.40	cryptoclass6.xhtml	216
1.9.41	cryptoclass7.xhtml	219
1.9.42	cryptoclass8.xhtml	223
1.9.43	cryptoclass9.xhtml	228
1.9.44	cryptoclass10.xhtml	232
1.9.45	cryptoclass11.xhtml	234
1.9.46	dbopbinary.xhtml	237
1.9.47	dbcharacteristic.xhtml	238
1.9.48	dbcomplexcomplex.xhtml	238
1.9.49	dbcomplexconjugate.xhtml	238
1.9.50	dbcomplexfactor.xhtml	238
1.9.51	dbcomplexdoublefloat.xhtml	239
1.9.52	dbcomplexfloat.xhtml	239
1.9.53	dbcompleximag.xhtml	239
1.9.54	dbcomplexnorm.xhtml	239
1.9.55	dbcomplexreal.xhtml	240
1.9.56	dbcomplexinteger.xhtml	240
1.9.57	dbexpressioninteger.xhtml	240
1.9.58	dbfractioninteger.xhtml	240
1.9.59	dbfractionpolynomialinteger.xhtml	241
1.9.60	dblookup.xhtml	241
1.9.61	dbopacos.xhtml	241
1.9.62	dbopacosh.xhtml	241
1.9.63	dbopacot.xhtml	242
1.9.64	dbopacoth.xhtml	242
1.9.65	dbopacsc.xhtml	242
1.9.66	dbopacsch.xhtml	242

1.9.67	dbopaddmod.xhtml	243
1.9.68	dbopairyai.xhtml	243
1.9.69	dbopairybi.xhtml	243
1.9.70	dbopapproximants.xhtml	243
1.9.71	dbopasin.xhtml	244
1.9.72	dbopasinh.xhtml	244
1.9.73	dbopasec.xhtml	244
1.9.74	dbopasech.xhtml	244
1.9.75	dbopatan.xhtml	245
1.9.76	dbopatanh.xhtml	245
1.9.77	dbopbernoullib.xhtml	245
1.9.78	dbopbesseli.xhtml	245
1.9.79	dbopbesselj.xhtml	246
1.9.80	dbopbesselk.xhtml	246
1.9.81	dbopbessely.xhtml	246
1.9.82	dbopbeta.xhtml	246
1.9.83	dbopcardinalnumber.xhtml	247
1.9.84	dbopchebyshevt.xhtml	247
1.9.85	dbopchebyshevu.xhtml	247
1.9.86	dbopcoefficient.xhtml	247
1.9.87	dbopcoefficients.xhtml	248
1.9.88	dbopcoerce.xhtml	248
1.9.89	dbopcolumn.xhtml	248
1.9.90	dbopcompactfraction.xhtml	248
1.9.91	dbopcomplexeigenvectors.xhtml	249
1.9.92	dbopcomplexelementary.xhtml	249
1.9.93	dbopcomplexintegrate.xhtml	249
1.9.94	dbopcomplexlimit.xhtml	249
1.9.95	dbopcomplexsolve.xhtml	250
1.9.96	dbopcontent.xhtml	250
1.9.97	dbopcontinuedfraction.xhtml	250
1.9.98	dbopconvergents.xhtml	250
1.9.99	dbopconvert.xhtml	251
1.9.100	dbopcopy.xhtml	251
1.9.101	dbopcos.xhtml	251
1.9.102	dbopcosh.xhtml	251
1.9.103	dbopcot.xhtml	252
1.9.104	dbopcoth.xhtml	252
1.9.105	dbopcount.xhtml	252
1.9.106	dbopcountableq.xhtml	252
1.9.107	dbopcreate3space.xhtml	253
1.9.108	dbopcsc.xhtml	253
1.9.109	dbopcsch.xhtml	253
1.9.110	dbopcurve.xhtml	253
1.9.111	dbopcycleragits.xhtml	254
1.9.112	dbopcyclotomic.xhtml	254

1.9.113 dbopd.xhtml	254
1.9.114 dbopdecimal.xhtml	254
1.9.115 dbopdefiningpolynomial.xhtml	255
1.9.116 dbopdegree.xhtml	255
1.9.117 dbopdenom.xhtml	255
1.9.118 dbopdraw.xhtml	255
1.9.119 dbopdeterminant.xhtml	256
1.9.120 dbopdiagonalmatrix.xhtml	256
1.9.121 dbopdigamma.xhtml	256
1.9.122 dbopdigits.xhtml	256
1.9.123 dbopdimension.xhtml	257
1.9.124 dbopdivide.xhtml	257
1.9.125 dbopdivisors.xhtml	257
1.9.126 dbopei.xhtml	257
1.9.127 dbopeigenmatrix.xhtml	258
1.9.128 dbopeigenvalues.xhtml	258
1.9.129 dbopeigenvector.xhtml	258
1.9.130 dbopeigenvectors.xhtml	258
1.9.131 dbopelt.xhtml	259
1.9.132 dbopequal.xhtml	259
1.9.133 dbopeulere.xhtml	259
1.9.134 dbopeulerphi.xhtml	259
1.9.135 dbopeval.xhtml	260
1.9.136 dbopevenq.xhtml	260
1.9.137 dbopexp.xhtml	260
1.9.138 dbopexquo.xhtml	260
1.9.139 dbopfactor.xhtml	261
1.9.140 dbopfactorfraction.xhtml	261
1.9.141 dbopfibonacci.xhtml	261
1.9.142 dbopfiniteq.xhtml	261
1.9.143 dbopfirstdenom.xhtml	262
1.9.144 dbopfirstnumer.xhtml	262
1.9.145 dbopfractragits.xhtml	262
1.9.146 dbopfractionpart.xhtml	262
1.9.147 dbopgamma.xhtml	263
1.9.148 dbopgcd.xhtml	263
1.9.149 dbophermiteh.xhtml	263
1.9.150 dbophex.xhtml	263
1.9.151 dbophorizconcat.xhtml	264
1.9.152 dbophtrigs.xhtml	264
1.9.153 dbophypergeometric0f1.xhtml	264
1.9.154 dbopinteger.xhtml	264
1.9.155 dbopintegrate.xhtml	265
1.9.156 dbopinverse.xhtml	265
1.9.157 dbopinvmod.xhtml	265
1.9.158 dbopjacobi.xhtml	265

1.9.159 dboplaguerrel.xhtml	266
1.9.160 dboplaurent.xhtml	266
1.9.161 dboplcm.xhtml	266
1.9.162 dbopleadingcoefficient.xhtml	266
1.9.163 dbopleadingmonomial.xhtml	267
1.9.164 dboplegendre.xhtml	267
1.9.165 dboplength.xhtml	267
1.9.166 dboplimit.xhtml	267
1.9.167 dboplog.xhtml	268
1.9.168 dboploggamma.xhtml	268
1.9.169 dbopmainvariable.xhtml	268
1.9.170 dbopmakegraphimage.xhtml	268
1.9.171 dbopmakeobject.xhtml	269
1.9.172 dbopmakeviewport3d.xhtml	269
1.9.173 dbopmap.xhtml	269
1.9.174 dbopmapbang.xhtml	269
1.9.175 dbopmatrix.xhtml	270
1.9.176 dbopmax.xhtml	270
1.9.177 dbopmemberq.xhtml	270
1.9.178 dbopmin.xhtml	270
1.9.179 dbopminimumdegree.xhtml	271
1.9.180 dbopminus.xhtml	271
1.9.181 dbopmoebiusmu.xhtml	271
1.9.182 dbopmonicdivide.xhtml	271
1.9.183 dbopmulmod.xhtml	272
1.9.184 dbopncols.xhtml	272
1.9.185 dbopnegativeq.xhtml	272
1.9.186 dbopnew.xhtml	272
1.9.187 dbopnextprime.xhtml	273
1.9.188 dbopnorm.xhtml	273
1.9.189 dbopnrows.xhtml	273
1.9.190 dbopnthfractionalterm.xhtml	273
1.9.191 dbopnthroot.xhtml	274
1.9.192 dbopnumer.xhtml	274
1.9.193 dbopnumeric.xhtml	274
1.9.194 dbopoddq.xhtml	274
1.9.195 dboponedimensionalarray.xhtml	275
1.9.196 dbopoperator.xhtml	275
1.9.197 dboporthonormalbasis.xhtml	275
1.9.198 dbopoutputfixed.xhtml	275
1.9.199 dbopoutputfloating.xhtml	276
1.9.200 dbopoutputgeneral.xhtml	276
1.9.201 dbopoutputspacing.xhtml	276
1.9.202 dboppadicfraction.xhtml	276
1.9.203 dbopnullity.xhtml	277
1.9.204 dbopnullspace.xhtml	277



1.9.205 dbopnumberoffractionalterms.xhtml	277
1.9.206 dboppartialfraction.xhtml	277
1.9.207 dboppartialquotients.xhtml	278
1.9.208 dbopplus.xhtml	278
1.9.209 dboppattern.xhtml	278
1.9.210 dboppermanent.xhtml	278
1.9.211 dboppi.xhtml	279
1.9.212 dboppolygamma.xhtml	279
1.9.213 dboppositiveq.xhtml	279
1.9.214 dboppositiveremainder.xhtml	279
1.9.215 dbopprefixragits.xhtml	280
1.9.216 dbopprevprime.xhtml	280
1.9.217 dbopprimefactor.xhtml	280
1.9.218 dbopprimeq.xhtml	280
1.9.219 dbopprimes.xhtml	281
1.9.220 dboppuiseux.xhtml	281
1.9.221 dbopqelt.xhtml	281
1.9.222 dbopqseteltbang.xhtml	281
1.9.223 dbopquatern.xhtml	282
1.9.224 dbopradicaleigenvectors.xhtml	282
1.9.225 dbopradicalsolve.xhtml	282
1.9.226 dbopranks.xhtml	282
1.9.227 dbopratdenom.xhtml	283
1.9.228 dboprealeigenvectors.xhtml	283
1.9.229 dboprealelementary.xhtml	283
1.9.230 dbopreduce.xhtml	283
1.9.231 dbopreductum.xhtml	284
1.9.232 dboprem.xhtml	284
1.9.233 dbopquo.xhtml	284
1.9.234 dbopresetvariableorder.xhtml	284
1.9.235 dbopresultant.xhtml	285
1.9.236 dboprootof.xhtml	285
1.9.237 dboprootsimp.xhtml	285
1.9.238 dboprootsof.xhtml	285
1.9.239 dbopseries.xhtml	286
1.9.240 dbopround.xhtml	286
1.9.241 dboprow.xhtml	286
1.9.242 dboprowechelon.xhtml	286
1.9.243 dbopsetcolumnbang.xhtml	287
1.9.244 dbopseteltbang.xhtml	287
1.9.245 dbopsetrowbang.xhtml	287
1.9.246 dbopsetelt.xhtml	287
1.9.247 dbopsetsubmatrixbang.xhtml	288
1.9.248 dbopsign.xhtml	288
1.9.249 dbopsimplify.xhtml	288
1.9.250 dbopseriesolve.xhtml	288

1.9.251 dbopsin.xhtml	289
1.9.252 dbopsintegerand.xhtml	289
1.9.253 dbopsintegernot.xhtml	289
1.9.254 dbopsintegeror.xhtml	289
1.9.255 dbopsintegerxor.xhtml	290
1.9.256 dbopsec.xhtml	290
1.9.257 dbopsech.xhtml	290
1.9.258 dbopsetvariableorder.xhtml	290
1.9.259 dbopsinh.xhtml	291
1.9.260 dbopsolve.xhtml	291
1.9.261 dbopsqrt.xhtml	291
1.9.262 dbopstar.xhtml	291
1.9.263 dbopstarstar.xhtml	292
1.9.264 dbopsubmatrix.xhtml	292
1.9.265 dbopsubmod.xhtml	292
1.9.266 dbopsurface.xhtml	292
1.9.267 dbopsumofkthpowerdivisors.xhtml	293
1.9.268 dboptan.xhtml	293
1.9.269 dboptanh.xhtml	293
1.9.270 dboptaylor.xhtml	293
1.9.271 dboptimes.xhtml	294
1.9.272 dboptotaldegree.xhtml	294
1.9.273 dboptrace.xhtml	294
1.9.274 dboptranspose.xhtml	294
1.9.275 dboptrigs.xhtml	295
1.9.276 dboptruncate.xhtml	295
1.9.277 dbopvariables.xhtml	295
1.9.278 dbopvectorise.xhtml	295
1.9.279 dbopvectorspace.xhtml	296
1.9.280 dbopwrite.xhtml	296
1.9.281 dbopzeroof.xhtml	296
1.9.282 dbopzerosof.xhtml	296
1.9.283 dbopzeroq.xhtml	297
1.9.284 dbopvertconcat.xhtml	297
1.9.285 dbopwholepart.xhtml	297
1.9.286 dbopolynomialinteger.xhtml	297
1.9.287 dbopolynomialfractioninteger.xhtml	298
1.9.288 dbopwholeragits.xhtml	298
1.9.289 definiteintegral.xhtml	299
1.9.290 determinantofhilbert.xhtml	300
1.9.291 differentiate.xhtml	302
1.9.292 dlmf.xhtml	303
1.9.293 dlmfapproximations.xhtml	305
1.9.294 dlmfasymptoticexpansions.xhtml	316
1.9.295 dlmfbarnesgfunction.xhtml	369
1.9.296 dlmfbetafunction.xhtml	388

1.9.297 dlmfcontinuedfractions.xhtml	420
1.9.298 dlmfdefinitions.xhtml	428
1.9.299 dlmffunctionrelations.xhtml	438
1.9.300 dlmfgraphics.xhtml	457
1.9.301 dlmfinequalities.xhtml	463
1.9.302 dlmfinfiniteproducts.xhtml	479
1.9.303 dlmfintegrals.xhtml	490
1.9.304 dlmfintegralrepresentations.xhtml	510
1.9.305 dlmfmathematicalapplications.xhtml	552
1.9.306 dlmfmethodsofcomputation.xhtml	563
1.9.307 dlmfmultidimensionalintegral.xhtml	565
1.9.308 dlmfnotation.xhtml	597
1.9.309 dlmfphysicalapplications.xhtml	606
1.9.310 dlmfpolygammafunctions.xhtml	619
1.9.311 dlmfqgammaandbetafunctions.xhtml	631
1.9.312 dlmfseriesexpansions.xhtml	650
1.9.313 dlmfsums.xhtml	669
1.9.314 dlmfsoftware.xhtml	672
1.9.315 dlmfspecialvaluesandextrema.xhtml	673
1.9.316 dlmftables.xhtml	702
1.9.317 draw.xhtml	756
1.9.318 draw2donevariable.xhtml	759
1.9.319 draw2ddefinedcurve.xhtml	761
1.9.320 draw2dpolynomialequation.xhtml	763
1.9.321 draw3dtwovariable.xhtml	765
1.9.322 draw3ddefinedtube.xhtml	767
1.9.323 draw3ddefinedsurface.xhtml	769
1.9.324 equdifferential.xhtml	771
1.9.325 equdifferentiallinear.xhtml	773
1.9.326 equdifferentialnonlinear.xhtml	777
1.9.327 equdifferentialpowerseries.xhtml	782
1.9.328 equationpage.xhtml	785
1.9.329 equsystemlinear.xhtml	787
1.9.330 examplesexposedpage.xhtml	790
1.9.331 factored.xhtml	790
1.9.332 foundationlibrarydocpage.xhtml	790
1.9.333 funalgebraicfunctions.xhtml	791
1.9.334 funelementaryfunctions.xhtml	793
1.9.335 funoperatoralgebra.xhtml	794
1.9.336 functionpage.xhtml	799
1.9.337 funpatternmatching.xhtml	801
1.9.338 funrationalfunctions.xhtml	810
1.9.339 funsimplification.xhtml	812
1.9.340 glossarypage.xhtml	815
1.9.341 graphexamples.xhtml	852
1.9.342 graphexamplesassorted.xhtml	853

1.9.343 graphexamplesimplicit.xhtml	855
1.9.344 graphexampleslistofpoints.xhtml	857
1.9.345 graphexamplesonevariable.xhtml	859
1.9.346 graphexamplesparametric.xhtml	860
1.9.347 graphexamplespolar.xhtml	862
1.9.348 graphexamplesthreed.xhtml	864
1.9.349 graphicspage.xhtml	866
1.9.350 graphviewports.xhtml	867
1.9.351 graph2d.xhtml	868
1.9.352 graph2dimplicit.xhtml	869
1.9.353 graph2dlistsofpoints.xhtml	870
1.9.354 graph2donevariable.xhtml	873
1.9.355 graph2dparametric.xhtml	875
1.9.356 graph2dpolar.xhtml	877
1.9.357 graph3d.xhtml	878
1.9.358 graph3dobjects.xhtml	879
1.9.359 graph3dparametric.xhtml	883
1.9.360 graph3dsurfaces.xhtml	885
1.9.361 graph3dtubeplots.xhtml	887
1.9.362 graph3dtwovariables.xhtml	889
1.9.363 htxtoppage.xhtml	890
1.9.364 indefiniteintegral.xhtml	891
1.9.365 introtofloat.xhtml	892
1.9.366 jenks.xhtml	894
1.9.367 laurentseries.xhtml	897
1.9.368 linalgpage.xhtml	899
1.9.369 linconversion.xhtml	902
1.9.370 lincreate.xhtml	906
1.9.371 lineigen.xhtml	911
1.9.372 linhilbert.xhtml	915
1.9.373 linintro.xhtml	917
1.9.374 linoperations.xhtml	920
1.9.375 linpermaent.xhtml	925
1.9.376 linsquarematrices.xhtml	927
1.9.377 linvectors.xhtml	929
1.9.378 lin1darrays.xhtml	933
1.9.379 lin2darrays.xhtml	936
1.9.380 man0page.xhtml	942
1.9.381 menualgebraadjointmatrix.xhtml	944
1.9.382 menualgebraapplytolist.xhtml	944
1.9.383 menualgebracharacteristicpolynomial.xhtml	944
1.9.384 menualgebradeterminant.xhtml	945
1.9.385 menualgebraeigenvalues.xhtml	945
1.9.386 menualgebraeigenvectors.xhtml	945
1.9.387 menualgebraentermatrix.xhtml	945
1.9.388 menualgebrainvertmatrix.xhtml	946

1.9.389 menualgebrageneratematrix.xhtml	946
1.9.390 menualgebramakelist.xhtml	946
1.9.391 menualgebramaptolist.xhtml	946
1.9.392 menualgebramaptomatrix.xhtml	947
1.9.393 menualgebrareducelist.xhtml	947
1.9.394 menualgebratransposematrix.xhtml	947
1.9.395 menuaxiomaddtopath.xhtml	947
1.9.396 menuaxiomclearmemory.xhtml	948
1.9.397 menuaxiomdeletefunction.xhtml	948
1.9.398 menuaxiomdeletevariable.xhtml	948
1.9.399 menuaxiominterrupt.xhtml	948
1.9.400 menuaxiomrestart.xhtml	949
1.9.401 menuaxiomshowdefinition.xhtml	949
1.9.402 menuaxiomdisplay.xhtml	949
1.9.403 menuaxiomset.xhtml	949
1.9.404 menuaxiomshowfunctions.xhtml	950
1.9.405 menuaxiomshowvariables.xhtml	950
1.9.406 menuaxiomtoggl timedisplay.xhtml	950
1.9.407 menucalculuscalculusum.xhtml	950
1.9.408 menucalculuscalculusproduct.xhtml	951
1.9.409 menucalculuschangevariable.xhtml	951
1.9.410 menucalculuscontinuedfractions.xhtml	951
1.9.411 menucalculusdifferentiate.xhtml	951
1.9.412 menucalculusdividepolynomials.xhtml	952
1.9.413 menucalculusfindlimit.xhtml	952
1.9.414 menucalculusgetseries.xhtml	952
1.9.415 menucalculusgreatestcommondivisor.xhtml	952
1.9.416 menucalculusleastcommonmultiple.xhtml	953
1.9.417 menucalculusintegrate.xhtml	953
1.9.418 menucalculusinverselaplacetransform.xhtml	953
1.9.419 menucalculuslaplacetransform.xhtml	953
1.9.420 menucalculuslevel3.xhtml	954
1.9.421 menucalculuslevel3a.xhtml	954
1.9.422 menucalculuslevel3b.xhtml	954
1.9.423 menucalculuslevel3c.xhtml	954
1.9.424 menucalculuspadeapproximation.xhtml	955
1.9.425 menucalculuspartialfractions.xhtml	955
1.9.426 menucalculusrischintegrate.xhtml	955
1.9.427 menueditcopy.xhtml	955
1.9.428 menueditcopyasimage.xhtml	956
1.9.429 menueditcopytex.xhtml	956
1.9.430 menueditcopytext.xhtml	956
1.9.431 menueditcut.xhtml	956
1.9.432 menueditpaste.xhtml	957
1.9.433 menueditdeleteselection.xhtml	957
1.9.434 menueditselectiontoimage.xhtml	957

1.9.435 menueditselectiontoinput.xhtml	957
1.9.436 menuequationsrealrootsofpolynomial.xhtml	958
1.9.437 menuequationsatvalue.xhtml	958
1.9.438 menuequationsboundaryvalueproblem.xhtml	958
1.9.439 menuequationsinitialvalueproblem1.xhtml	958
1.9.440 menuequationsinitialvalueproblem2.xhtml	959
1.9.441 menuequationssolvealgebraicsystem.xhtml	959
1.9.442 menuequationsseliminatevariable.xhtml	959
1.9.443 menuequationssolveinearsystem.xhtml	959
1.9.444 menuequationssolveode.xhtml	960
1.9.445 menuequationssolveodewithlaplace.xhtml	960
1.9.446 menuequationsrootsofpolynomial.xhtml	960
1.9.447 menuequationssolve.xhtml	960
1.9.448 menuequationssolvenumerically.xhtml	961
1.9.449 menufileexit.xhtml	961
1.9.450 menufileinputfile.xhtml	961
1.9.451 menufileloadlibrary.xhtml	961
1.9.452 menufileopen.xhtml	962
1.9.453 menufileprint.xhtml	962
1.9.454 menufileread.xhtml	962
1.9.455 menufilesave.xhtml	962
1.9.456 menufilesaveas.xhtml	963
1.9.457 menufiletogglespool.xhtml	963
1.9.458 menunumericsetprecision.xhtml	963
1.9.459 menunumerictobigfloat.xhtml	963
1.9.460 menunumerictofloat.xhtml	964
1.9.461 menunumerictogglenumericoutput.xhtml	964
1.9.462 menusimplifyaddalgebraicequality.xhtml	964
1.9.463 menusimplifycomplexsimplification.xhtml	964
1.9.464 menusimplifycontractlogarithms.xhtml	965
1.9.465 menusimplifyevalutenounform.xhtml	965
1.9.466 menusimplifyexpandexpression.xhtml	965
1.9.467 menusimplifyexpandlogarithms.xhtml	965
1.9.468 menusimplifyfactorialsandgamma.xhtml	966
1.9.469 menusimplifyfactorcomplex.xhtml	966
1.9.470 menusimplifyfactorexpression.xhtml	966
1.9.471 menusimplifymoduluscomputation.xhtml	966
1.9.472 menusimplifysimplifyexpression.xhtml	967
1.9.473 menusimplifysubstitute.xhtml	967
1.9.474 menusimplifysimplifyradicals.xhtml	967
1.9.475 menusimplifytogglealgebraicflag.xhtml	967
1.9.476 menusimplifytrigsimplification.xhtml	968
1.9.477 numbasicfunctions.xhtml	969
1.9.478 numberspage.xhtml	976
1.9.479 numcardinalnumbers.xhtml	978
1.9.480 numcomplexnumbers.xhtml	983

1.9.481 numcontinuedfractions.xhtml	987
1.9.482 numexamples.xhtml	994
1.9.483 numfactorization.xhtml	996
1.9.484 numfinitefields.xhtml	998
1.9.485 numfloat.xhtml	1000
1.9.486 numfractions.xhtml	1002
1.9.487 numfunctions.xhtml	1004
1.9.488 numgeneralinfo.xhtml	1010
1.9.489 numintegerfractions.xhtml	1010
1.9.490 numintegers.xhtml	1011
1.9.491 nummachinefloats.xhtml	1014
1.9.492 nummachinesizedintegers.xhtml	1018
1.9.493 numnumbertheoreticfunctions.xhtml	1021
1.9.494 numnumericfunctions.xhtml	1024
1.9.495 numoctonions.xhtml	1036
1.9.496 numotherbases.xhtml	1040
1.9.497 numpartialfractions.xhtml	1044
1.9.498 numproblems.xhtml	1048
1.9.499 numquaternions.xhtml	1051
1.9.500 numquotientfields.xhtml	1054
1.9.501 numrationalnumbers.xhtml	1058
1.9.502 numrepeatingbinaryexpansions.xhtml	1060
1.9.503 numrepeatingdecimals.xhtml	1062
1.9.504 numrepeatinghexexpansions.xhtml	1064
1.9.505 numromannumerals.xhtml	1066
1.9.506 ocwmit18085.xhtml	1069
1.9.507 ocwmit18085lecture1.xhtml	1070
1.9.508 ocwmit18085lecture2.xhtml	1079
1.9.509 operations.xhtml	1079
1.9.510 outputfunctions.xhtml	1080
1.9.511 pagelist.xhtml	1082
1.9.512 pagematrix.xhtml	1082
1.9.513 pageonedimensionalarray.xhtml	1082
1.9.514 pageset.xhtml	1082
1.9.515 pagetable.xhtml	1083
1.9.516 pagepermanent.xhtml	1083
1.9.517 pagesquarematrix.xhtml	1083
1.9.518 pagetwodimensionalarray.xhtml	1084
1.9.519 pagevector.xhtml	1089
1.9.520 polybasicfunctions.xhtml	1090
1.9.521 polyfactorization.xhtml	1094
1.9.522 polyfactorization1.xhtml	1095
1.9.523 polyfactorization2.xhtml	1096
1.9.524 polyfactorization3.xhtml	1097
1.9.525 polyfactorization4.xhtml	1099
1.9.526 polygcdandfriends.xhtml	1100

1.9.527 polynomialpage.xhtml	1102
1.9.528 polyroots.xhtml	1104
1.9.529 polyroots1.xhtml	1106
1.9.530 polyroots2.xhtml	1108
1.9.531 polyroots3.xhtml	1111
1.9.532 polyroots4.xhtml	1114
1.9.533 polyspecificitytypes.xhtml	1117
1.9.534 polyspecificitytypes1.xhtml	1119
1.9.535 polyspecificitytypes2.xhtml	1131
1.9.536 polyspecificitytypes3.xhtml	1140
1.9.537 polyspecificitytypes4.xhtml	1144
1.9.538 polysubstitutions.xhtml	1147
1.9.539 puiseuxseries.xhtml	1149
1.9.540 reallimit.xhtml	1151
1.9.541 refsearchpage.xhtml	1152
1.9.542 releasenotes.xhtml	1153
1.9.543 rootpage.xhtml	1155
1.9.544 series.xhtml	1158
1.9.545 serieexpand.xhtml	1160
1.9.546 solve.xhtml	1161
1.9.547 solvelinearequations.xhtml	1162
1.9.548 solvelinearmatrix.xhtml	1165
1.9.549 solvesinglepolynomial.xhtml	1170
1.9.550 solvesystempolynomials.xhtml	1171
1.9.551 summation.xhtml	1171
1.9.552 systemvariables.xhtml	1172
1.9.553 taylorseries.xhtml	1173
1.9.554 topexamplepage.xhtml	1175
1.9.555 topicspage.xhtml	1176
1.9.556 topreferencepage.xhtml	1178
1.9.557 topsettingspage.xhtml	1179
1.9.558 tutorial.xhtml	1179
1.9.559 uglangpage.xhtml	1180
1.9.560 ugsyscmdpage.xhtml	1180
1.9.561 usersguidepage.xhtml	1180
1.9.562 rcm3720.input	1181
1.9.563 signatures.txt	1182
1.9.564 strang.input	1183
1.9.565 bitmaps/axiom1.bitmap	1184
1.10 License	1191



## Volume 12: Axiom Crystal

<b>1</b>	<b>Axiom Crystal Design</b>	<b>1</b>
1.1	Book presentation . . . . .	1
1.1.1	Book spines . . . . .	1
1.1.2	Linking information . . . . .	2
<b>2</b>	<b>Experiments</b>	<b>3</b>
2.1	Hide/Show a div element . . . . .	3
2.2	Hide/Show a nested div element . . . . .	4
2.3	Hide/Show a ring of elements . . . . .	5
<b>3</b>	<b>Other work</b>	<b>9</b>
3.1	Understanding the Dynamics of Complex Lisp Programs [?] . . . . .	9

**Bibliography: Axiom Bibliography**

0.1	Axiom Citations in the Literature . . . . .	v
0.2	Axiom Citations of External Sources . . . . .	xxii