Contents

List of Tables 6

Preface 8

Chapter 1 Getting Started, Desktop Environment, and Overview 10

1.1 Start and Quit MATLAB 11
1.2 Entering Commands 13
1.3 Array Expressions 17
1.4 Data Visualization: Line Plots 19
1.5 MATLAB Scripts 22
1.6 Data Visualization: Surface Plots 25
1.7 Symbolic Mathematics 29
1.8 Live Script 32
1.9 Screen Text Input/Output 34
1.10 Text File Input/Output 38
1.11 Debug Your Programs 41
1.12 Binary File Input/Output 44
1.13 Images and Sounds 45
1.14 Flow Controls 47
1.15 User-Defined Functions 48
1.16 Cell Arrays 51
1.17 Structures 53
1.18 Graphical User Interfaces (GUI) 55
1.19 GUIDE 58
1.20 App Designer 63

Chapter 2 Data Types, Operators, and Expressions 68

2.1 Unsigned Integers 69
2.2 Signed Integers 72
2.3 Floating-Point Numbers 74
2.4 Character and Strings 78
2.5 Logical Data 81
2.6 Arrays 84
2.7 Sums, Products, Minima, and Maxima 89
2.8 Arithmetic Operators 92
2.9 Relational and Logical Operators 99
2.10 String Manipulations 102
2.11 Expressions 105
2.12 Example: Function Approximations 108
2.13 Example: Series Solution of a Laplace Equation 113
2.14 Example: Deflection of Beams 115
2.15 Example: Vibrations of Supported Machines 117
2.16 Additional Exercise Problems 121

Chapter 3 Flow Controls, Functions, and Programs 124

3.1 If-Blocks 125
3.2 Switch-Blocks 127
3.3 While-Loops 129
3.4 For-Loops 131
3.5 User-Defined Functions 134
3.6 Subfunctions 137
3.7 Nested Functions 139
3.8 Function Handles 141
3.9 Anonymous Functions 144
3.10 Function Precedence Order 146
3.11 Program Files 147
3.12 Example: Deflection of Beams 149
3.13 Example: Sorting and Searching 151
3.14 Example: Statically Determinate Trusses (Version 1.0) 154
3.15 Example: Statically Determinate Trusses (Version 2.0) 159
3.16 Additional Exercise Problems 169

Chapter 4 Cell Arrays, Structures, Tables, and User-Defined Classes 170

4.1 Cell Arrays 171
4.2 Functions of Variable-Length Arguments 175
4.3 Structures 179
4.4 Example: Statically Determinate Trusses (Version 3.0) 182
4.5 Tables 187
4.6 Conversion of Cell Arrays 191
4.7 Conversion of Structure Arrays 194
4.8 Conversion of Tables 197
4.9 User-Defined Classes 200
4.10 Additional Exercise Problems 204

Chapter 5 Data Visualization: Plots 206

5.1 Graphics Objects and Parent-Children Relationship 207
5.2 Graphics Objects Properties 212
5.3 Figure Objects 216
5.4 Axes Objects 218
5.5 Line Objects 224
5.6 Text Objects 227
5.7 Legend Objects 231
5.8 Bar Plots 233
5.9 Pie Plots 235
5.10 3-D Line Plots 237
5.11 Surface and Mesh Plots 239
5.12 Contour Plots 245
5.13 Vector Plots 248
5.14 Streamline Plots 250
5.15 Isosurface Plots 252
5.16 Additional Exercise Problems 253

Chapter 6 Animations, Images, Audios, and Videos 256

6.1 Animation of Line Plots: Comet 257
6.2 Stream Particles Animations 258
6.3 Movie: Animation of an Engine 260
6.4 Indexed Images 262
6.5 True Color Images 264
6.6 Audios 267
6.7 Videos 270
6.8 Example: Statically Determinate Trusses (Version 4.0) 272
6.9 Additional Exercise Problems 275

Chapter 7 Data Import and Export 277

7.1 Screen Text I/O 278
7.2 Low-Level Text File I/O 281
7.3 Low-Level Binary File I/O 286
7.4 MAT-Files 288
7.5 ASCII-Delimited Files 290
7.6 Excel Spreadsheet Files 292
7.7 Additional Exercise Problems 293

Chapter 8 Graphical User Interfaces 295

8.1 Predefined Dialog Boxes 296
8.2 UI-Controls: Pushbuttons 300
8.3 Example: Image Viewer 304
8.4 UI-Menus: Image Viewer 307
8.5 Panels, Button Groups, and More UI-Controls 309
8.6 UI-Controls: Sliders 315
8.7 UI-Tables: Truss Data 317
8.8 Example: Statically Determinate Trusses (Version 5.0) 320
8.9 GUIDE 328
8.10 App Designer 339
8.11 Additional Exercise Problems 356

Chapter 9 Symbolic Mathematics 357

9.1 Symbolic Numbers, Variables, Functions, and Expressions 358
9.2 Simplification of Expressions 364
9.3 Symbolic Differentiation: Curvature of a Planar Curve 367
9.4 Symbolic Integration: Normal Distributions 370
9.5 Limits 372
9.6 Taylor Series 374
9.7 Algebraic Equations 376
9.8 Inverse of Matrix: Hooke's Law 379
9.9 Ordinary Differential Equations (ODE) 381
9.10 Additional Exercise Problems 387

Chapter 10 Linear Algebra, Polynomial, Curve Fitting, and Interpolation 388

10.1 Products of Vectors 389
10.2 Systems of Linear Equations 394
10.3 Backslash Operator (\) 399
10.4 Eigenvalue Problems 402
10.5 Polynomials 404
10.6 Polynomial Curve Fittings 408
10.7 Interactive Curve-Fitting Tools 411
10.8 Linear Fit Through Origin: Brake Assembly 413
10.9 Interpolations 418
10.10 Two-Dimensional Interpolations 421

Chapter 11 Differentiation, Integration, and Differential Equations 422

11.1 Numerical Differentiation 423
11.2 Numerical Integration: `trapz` 426
11.3 Length of a Curve 428
11.4 User-Defined Function as Input Argument: `integral` 431
11.5 Area and Centroid 432
11.6 Placing Weight on Spring Scale 434
11.7 Double Integral: Volume Under Stadium Dome 437
11.8 Initial Value Problems 439
11.9 IVP: Placing Weight on Spring Scale 442
11.10 ODE-BVP: Deflection of Beams 444
11.11 IBVP: Heat Conduction in a Wall 447

Chapter 12 Nonlinear Equations and Optimization 450

12.1 Nonlinear Equations: Intersection of Two Curves 451
12.2 Kinematics of Four-Bar Linkage 453
12.3 Asymmetrical Two-Spring System 456
12.4 Linear Programming: Diet Problem 459
12.5 Mixed-Integer Linear Programming 463
12.6 Unconstrained Single-Variable Optimization 466
12.7 Unconstrained Multivariate Optimization 469
12.8 Multivariate Linear Regression 472
12.9 Non-Polynomial Curve Fitting 475
12.10 Constrained Optimization 479

Chapter 13 Statistics 484

13.1 Descriptive Statistics 485
13.2 Normal Distribution 491
13.3 Central Limit Theory 495
13.4 Confidence Interval 499
13.5 Chi-Square Distribution 501
13.6 Student's *t*-Distribution 506
13.7 One-Sample *t*-Test: Voltage of Power Supply 509
13.8 Linear Combination of Random Variables 511
13.9 Two-Sample *t*-Test: Injection Molded Plastic 512
13.10 *F*-Distribution 514
13.11 Two-Sample *F*-Test: Injection Molded Plastic 516
13.12 Comparison of Means by *F*-Test 518

Index 520