

CONTENTS

PREFACE

1. OVERVIEW OF MAPLE	1
1.1 Introduction	1
1.2 An Overview of Maple	2
1.2.1 Statements and Commands	2
1.2.2 Elementary Operations	2
1.2.3 Variables	6
1.2.4 Numbers, Lists, and Sets	7
1.2.5 Algebraic and Transcendental Equations	8
1.2.6 Differential Equations	10
1.2.7 Manipulation and Simplification	12
1.2.8 Functional Relationships and Procedures	14
1.3 The Maple Library	16
1.4 Graphics	17
References	20
2. MATHEMATICAL FUNCTIONS	21
2.1 Introduction	21
2.2 Hyperbolic Functions	21
2.3 The Error Function	24
2.4 Bessel Functions	27
2.5 The Exponential Integral Function	33
2.6 The Gamma and the Incomplete Gamma Functions	34
2.7 The Beta Function	35
2.8 Generalized Hypergeometric Function	36
References	37
3. ALGEBRAIC AND TRANSCENDENTAL EQUATIONS	39
3.1 Introduction	39
3.2 System of Algebraic Equations	40
3.3 Transcendental Equations	42
3.3.1 Numerical Methods	42
3.3.1.1 The Secant Method	42
3.3.1.2 The Bisection Method	43
3.3.1.3 Newton's Method	45
3.3.2 Direct Solutions	46
3.3.2.1 Transient Conduction in a Plane Wall	46
3.3.2.2 Transient Conduction in a Solid Cylinder	47
3.3.2.3 Optimum Design of Fins	49
3.3.2.4 Phase Change in Planar Geometry	54
3.3.2.5 Phase Change in Cylindrical Geometry	56
References	58

4. ELEMENTARY ONE-DIMENSIONAL STEADY CONDUCTION	59
4.1 Introduction	59
4.2 The Plane Wall	59
4.3 The Hollow Cylinder	62
4.4 The Hollow Sphere	65
4.5 Truncated Conical Sections	67
4.6 Composite Sections	71
4.6.1 The Composite Plane Wall	71
4.6.2 The Composite Hollow Cylinder	75
4.6.3 The Composite Hollow Sphere	79
4.7 Heat Conduction with Uniform Heat Generation	82
4.7.1 The Plane Wall	82
4.7.2 The Composite Hollow Cylinder	87
5. ADVANCED ONE-DIMENSIONAL STEADY CONDUCTION	93
5.1 Introduction	93
5.2 Variable Thermal Conductivity	94
5.2.1 Location Dependent Thermal Conductivity	94
5.2.2 Temperature Dependent Thermal Conductivity	99
5.3 Non uniform Heat Generation	104
5.3.1 Location Dependent Heat Generation	104
5.3.2 Temperature Dependent Heat Generation	110
5.4 Combined Radiative Convective Cooling with Uniform Heat Generation	115
5.5 Optimum Design of Thermal Systems	123
6. EXTENDED SURFACES	129
6.1 Introduction	129
6.2 The General Fin Equation	129
6.3 Straight Fins	130
6.3.1 Rectangular Fins	131
6.3.2 Trapezoidal Fin	140
6.3.3 Triangular Fin	145
6.3.4 Concave Parabolic Fin	148
6.4 Spines	150
6.4.1 Performance Analysis of a Conical Spine	150
6.4.2 Efficiency of Cylindrical and Rectangular Spines	152
6.4.2.1 Cylindrical and Rectangular Spines	152
6.4.2.2 Efficiency of Conical Spine	153
6.4.2.3 Efficiency of Concave Parabolic Spine	153
6.4.2.4 Efficiency of Convex Parabolic Spine	153
6.5 Annular Fin of Rectangular Profile	157
6.6 Finned Array	161
6.6.1 Cascaded Rectangular-Triangular Fin	162
6.6.2 Capped Hollow Tube Transistor Heat Sink	168
6.6.3 The Y-Shaped Fin Array	173
6.7 Convecting-Radiating Fins	179
References	184

7. T

7

7

7

7

7

7

7

R

8. T

8.

8.

8.

8.

8.

8.

8.

R

INDE

7. TWO-DIMENSIONAL STEADY STATE CONDUCTION	185
7.1 Introduction	185
7.2 The Method of Separation of Variables in Cartesian Coordinates	186
7.3 The Method of Separation of Variables in Cylindrical Coordinates	193
7.4 The Method of Separation of Variables in Spherical Coordinates	200
7.5 The Finite Difference Method	204
7.5.1 Cartesian Coordinate System	205
7.5.2 Cylindrical Coordinate System	206
7.5.3 Cartesian Coordinates with Curved Boundaries	208
References	219
8. TRANSIENT CONDUCTION	221
8.1 Introduction	221
8.2 The Lumped Capacity Model	222
8.2.1 Convective Cooling with Constant Properties	222
8.2.2 Convective Cooling with Temperature Dependent Specific Heat	224
8.2.3 Radiative Cooling with Constant Properties	227
8.2.4 Convective Cooling with Temperature Dependent Heat Transfer Coefficient	230
8.3 The Semi-Infinite Solid	232
8.3.1 The Laplace Transform Method	232
8.3.1.1 Specified Surface Temperature	233
8.3.1.2 Constant Surface Heat Flux	237
8.3.1.3 Surface Convection	239
8.3.2 The Similarity Technique	246
8.4 The Plane Wall with Convection	255
8.4.1 The Method of Separation of Variables	256
8.4.2 Explicit Finite Difference Method	261
8.4.3 Implicit Finite Difference Method	264
8.5 Solid Cylinder with Sudden Change in Surface Temperature	265
8.6 Oscillatory Heat Transfer in a Rectangular Fin	269
References	279
INDEX	280