

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. 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 |