

CONTENTS

CHAPTER 1 BASIC RELATIONS

1

- 1.1 Derivation of the Balance Equation, 1
- 1.2 Equation of Conservation of Mass for a Multicomponent System, 4
- 1.3 Differential Equation of Linear Diffusion, 5
- 1.4 The Linear Boundary Conditions, 7
- 1.5 Classification of Linear Boundary Value Problems of Heat and Mass Diffusion, 9
- 1.6 Transformation of Coordinates, 14
- 1.7 Reduction to Two- and One-Dimensional Forms, 17
- References, 20

CHAPTER 2 THE GENERAL SOLUTIONS OF SEVEN DIFFERENT CLASSES OF HEAT AND MASS DIFFUSION PROBLEMS

21

- 2.1 General Solution of Problems of Class I, 27
- 2.2 General Solution of Problems of Class II, 45
- 2.3 General Solution of Problems of Class III, 55
- 2.4 General Solution of Problems of Class IV, 64
- 2.5 General Solution of Problems of Class V, 68
- 2.6 General Solution of Problems of Class VI, 72
- 2.7 General Solution of Problems of Class VII, 78
- References, 84

CHAPTER 3 EIGENVALUE PROBLEMS

86

- 3.1 Eigenvalue Problem of Class I, 86
- 3.2 Eigenvalue Problem of Class II, 122
- 3.3 Eigenvalue Problem of Class III, 130
- 3.4 Eigenvalue Problem of Class IV, 135
- 3.5 Eigenvalue Problem of Class V, 137
- 3.6 Eigenvalue Problem of Class VI, 140
- 3.7 Eigenvalue Problem of Class VII, 142
- References, 144

CHAPTER 4 ONE-DIMENSIONAL PROBLEMS	146
4.1 One-Dimensional Problems of Class I,	146
4.2 One-Dimensional Problems of Class II,	176
4.3 One-Dimensional Problems of Class III,	181
4.4 One-Dimensional Problems of Class IV,	186
4.5 One-Dimensional Problems of Class V,	188
4.6 One-Dimensional Problems of Class VI,	190
4.7 One-Dimensional Problems of Class VII,	191
References,	193
 CHAPTER 5 CLASS I SOLUTIONS APPLIED TO STEADY-STATE DIFFUSION	 194
5.1 Statement of the Steady-State Class I Problems,	194
5.2 One-Dimensional Steady-State Diffusion,	197
5.3 Multidimensional Steady-State Problems in the Rectangular Coordinate System,	205
5.4 Multidimensional Steady-State Problems in the Cylindrical Coordinate System,	220
5.5 Multidimensional Steady-State Problems in the Spherical Coordinate System,	230
References,	233
 CHAPTER 6 CLASS I SOLUTIONS APPLIED TO HEAT FLOW THROUGH FINS	 234
6.1 General Analysis of Heat Flow Through Fins,	234
6.2 Heat Flow Through Fins—Applications,	243
6.3 Heat Transfer Through an Array of Fins,	260
References,	270
 CHAPTER 7 CLASS I SOLUTIONS APPLIED TO TIME DEPENDENT HEAT AND MASS DIFFUSION	 271
7.1 Formulation of Heat and Mass Diffusion Problems of Class I,	271
7.2 One-dimensional Time Dependent Diffusion in Slab, Cylinder, and Sphere,,	277
7.3 One-dimensional Time Dependent Diffusion in Semi-infinite Regions,	325
7.4 Time Dependent Temperature Distribution in a Transpiration-Cooled Porous Plate,	330
References,	336

CHAPTER 8 CLASS I SOLUTIONS APPLIED TO FORCED CONVECTION IN CONDUITS	337
8.1 Steady Fully Developed Flow Through Conduits,	337
8.2 Unsteady Fully Developed Flow Through Conduits,	345
8.3 Forced Convection Heat Transfer in Conduits,	353
References,	376
CHAPTER 9 CLASS II SOLUTIONS APPLIED TO HEAT DIFFUSION IN ONE-DIMENSIONAL COMPOSITE MEDIA	378
9.1 Formulation of Transient Heat Conduction for One-Dimensional Composite Media,	378
9.2 Formal Solution for n -Layer Composite Medium,	380
9.3 Construction of Eigenfunctions,	383
9.4 Determination of Eigenvalues and Eigenfunctions,	385
9.5 Summary of General Solutions for Layers of Slabs, Cylinders, and Spheres,	393
References,	397
CHAPTER 10 CLASS III SOLUTIONS APPLIED TO HEAT AND MASS TRANSFER IN CAPILLARY POROUS BODY AND HEAT TRANSFER IN ENTRANCE CONCURRENT FLOW	399
10.1 Luikov's Equations of Heat and Mass Diffusion in Capillary Porous Bodies,	399
10.2 Temperature and Moisture Distributions During Contact Drying of a Sheet of Porous Moist Material,	401
10.3 Entrance Region Heat or Mass Transfer in Concurrent Flow,	411
References,	424
Notes,	425
CHAPTER 11 CLASS IV SOLUTIONS APPLIED TO HEAT OR MASS DIFFUSION IN ONE-DIMENSIONAL HETEROGENEOUS MEDIA	429
11.1 Formulation of Transient Heat or Mass Diffusion in One-Dimensional Heterogeneous Media,	430
11.2 Solutions for Components' Potentials (Temperature or Mass Concentration),	432

11.3	Distribution of Potentials in an Heterogeneous Slab, Long Solid Cylinder, and Sphere,	436
	References,	439
	Notes,	439
CHAPTER 12 CLASS V SOLUTIONS APPLIED TO MASS DIFFUSION IN CHEMICALLY REACTING SYSTEMS		441
12.1	Solution for Potentials for Monotype Homogeneous Boundary Conditions,	442
12.2	Solution for Both Boundary Conditions of the Second Kind,	446
12.3	Solution for the Average Potentials $T_{av,k}(t)$,	448
12.4	Solution for the Steady-State Potentials $T_{0k}(x)$,	451
12.5	Solution for the Transient Homogeneous Potentials $T_{ik}(x, t)$,	454
	References,	460
CHAPTER 13 CLASS VI SOLUTION APPLIED TO HEAT AND MASS DIFFUSION AND DEVELOPING DUCT FLOW		461
13.1	Heating of Bodies in a Limited Volume of Well-Stirred Fluid,	461
13.2	Mass Diffusion into a Body from a Limited Volume of Well-Stirred Fluid,	474
13.3	Flow Development in the Hydrodynamic Entrance Region of Ducts,	485
	References,	494
	Notes,	495
CHAPTER 14 CLASS VII SOLUTIONS APPLIED TO DIFFUSION WITH CHEMICAL REACTION		500
14.1	Reversible Reaction,	501
14.2	Instantaneous Reaction,	510
14.3	Irreversible Reaction,	512
14.4	Numerical Results,	514
	References,	517
INDEX		519

