

Contents

	Preface	ix
1	Introduction	1
1.1	Mathematical Modelling	1
1.2	Use of Computers for Mathematical Modelling	3
1.3	Computational Experiment	6
1.4	Numerical Modelling of Heat Transfer Processes	12
2	Mathematical Models of Physics of Heat	15
2.1	Heat Conduction in Solids	16
2.2	Closing Relations	22
2.3	Phase Transitions	30
2.4	Convective Heat Transfer	37
2.5	Thermal Radiation of Solids	45
2.6	Thermoelasticity	49
2.7	Bibliography and Comments	55
3	Analytical Methods of Heat Transfer	57
3.1	Dimensionless Analysis	58
3.2	Analytical Solution of Linear Problems	62
3.3	Exact Solutions of Nonlinear Problems	69
3.4	Asymptotic Methods of Heat Transfer	75
3.5	Bibliography and Comments	84
4	Stationary Problems of Heat Transfer	87
4.1	Boundary Value Problems for Second-order Elliptic Problems	88
4.2	Construction of Difference Schemes	97
4.3	Uniform Convergence of Difference Schemes	122
4.4	Convergence of Difference Schemes in an Energetic Space	135
4.5	Direct Methods for Solving Grid Equations	152
4.6	Iterative Methods of Linear Algebra	162
4.7	Iterative Methods for Solving Grid Equations	170

4.8	Numerical Solution of Problems in Irregular Domains	188
4.9	Nonlinear Problems of Stationary Heat Transfer	207
4.10	Bibliography and Comments	218
5	Nonstationary Problems of Heat Trasfer	223
5.1	Boundary Value Problems for Second-Order Parabolic Equations	224
5.2	Difference Schemes for Nonstationary Problems	231
5.3	Uniform Convergence of Difference Schemes for the Heat Equation	239
5.4	Theory of Stability of Difference Schemes	248
5.5	Stability and Convergence of Difference Schemes for the Heat Equation	260
5.6	Asymptotical Stability of Difference Schemes for the Heat Equation	267
5.7	Hyperbolic Heat Equation	275
5.8	Regularization of Difference Schemes	280
5.9	Nonlinear Nonstationary Problems	286
5.10	Bibliography and Comments	295
6	Economical Difference Schemes for Nonstationary Heat Conduction Problems	299
6.1	Implementation of Implicit Schemes on a Computer	300
6.2	The Method of Alternating Directions	309
6.3	Factorized Difference Schemes for the Heat Equation	316
6.4	Additive Difference Schemes	324
6.5	Locally One-dimensional Difference Schemes	334
6.6	Bibliography and Comments	344
7	Heat Conduction Problems with Phase Transi- tions	347
7.1	Variable Domain Methods	348
7.2	Fixed Domain Methods	361
7.3	Transformation of Dependent Variables	370
7.4	Quasi-Stationary Stefan Problem	377
7.5	Modelling of Phase Transitions in Binary Alloys	388
7.6	Bibliography and Comments	394
	Index	397