CONTENTS

PREFACE x

INTRODUCTION xii

1 Fundamentals of linear thermoelasticity with finite wave speeds 1

1.1 Fundamentals of classical thermoelasticity 1

1.1.1 Basic considerations 1

1.1.2 Global balance law in terms of (u_i, ϑ) 7

1.1.3 Global balance law in terms of (S_{ij}, q_i) 9

1.2 Fundamentals of thermoelasticity with one relaxation time 11

1.2.1 Basic considerations 11

1.2.2 Global balance law in terms of (u_i, ϑ) 14

1.2.3 Global balance law in terms of (S_{ij}, q_i) 15

1.3 Fundamentals of thermoelasticity with two relaxation times 18

1.3.1 Basic considerations 18

1.3.2 Global balance law in terms of (u_i, ϑ) 25

1.3.3 Global balance law in terms of (S_{ij}, ϑ) 26

2 Formulations of initial-boundary value problems 30

2.1 Conventional and non-conventional characterization of a thermoelastic process 30

2.1.1 Two mixed initial-boundary value problems in the L–S theory 31

2.1.2 Two mixed initial-boundary value problems in the G–L theory 33

2.2 Relations among descriptions of a thermoelastic process in terms of various pairs of thermomechanical variables 34

3 Existence and uniqueness theorems 37

3.1 Uniqueness theorems for conventional and non-conventional thermoelastic processes 37

3.2 Existence theorem for a non-conventional thermoelastic process 43

4 Domain of influence theorems 51

4.1 The potential–temperature problem in the Lord–Shulman theory 51

4.2 The potential–temperature problem in the Green–Lindsay theory 59

4.3 The natural stress–heat-flux problem in the Lord–Shulman theory 65

4.4 The natural stress–temperature problem in the Green–Lindsay theory 71
4.5 The displacement–temperature problem for an inhomogeneous anisotropic body in the L–S and G–L theories 80
4.5.1 A thermoelastic wave propagating in an inhomogeneous anisotropic L–S model 80
4.5.2 A thermoelastic wave propagating in an inhomogeneous anisotropic G–L model 83

5 Convolutional variational principles 86
5.1 Alternative descriptions of a conventional thermoelastic process in the Green–Lindsay theory 86
5.2 Variational principles for a conventional thermoelastic process in the Green–Lindsay theory 93
5.3 Variational principle for a non-conventional thermoelastic process in the Lord–Shulman theory 103
5.4 Variational principle for a non-conventional thermoelastic process in the Green–Lindsay theory 106

6 Central equation of thermoelasticity with finite wave speeds 111
6.1 Central equation in the Lord–Shulman and Green–Lindsay theories 111
6.2 Decomposition theorem for a central equation of Green–Lindsay theory. Wave-like equations with a convolution 114
6.3 Speed of a fundamental thermoelastic disturbance in the space of constitutive variables 127
6.4 Attenuation of a fundamental thermoelastic disturbance in the space of constitutive variables 139
6.4.1 Behavior of functions $\hat{k}_{1.2}$ for a fixed relaxation time t_0 140
6.4.2 Behavior of functions $\hat{k}_{1.2}$ for a fixed ϵ 141
6.5 Analysis of the convolution coefficient and kernel 143
6.5.1 Analysis of $\hat{\lambda}$ at fixed t_0 143
6.5.2 Analysis of $\hat{\lambda}$ at fixed ϵ 144
6.5.3 Analysis of the convolution kernel 146

7 Exact aperiodic-in-time solutions of Green–Lindsay theory 152
7.1 Fundamental solutions for a 3D bounded domain 152
7.2 Solution of a potential–temperature problem for a 3D bounded domain 164
7.3 Solution for a thermoelastic layer 170
7.4 Solution of Nowacki type; spherical wave of a negative order 175
7.5 Solution of Danilovskaya type; plane wave of a negative order 192
7.6 Thermoelastic response of a half-space to laser irradiation 197

8 Kirchhoff-type formulas and integral equations in Green–Lindsay theory 217
8.1 Integral representations of fundamental solutions 217

8.2 Integral equations for fundamental solutions 221
8.3 Integral representation of a solution to a central system of equations 222
8.4 Integral equations for a potential–temperature problem 232

9 Thermoelastic polynomials 241
9.1 Recurrence relations 241
9.2 Differential equation 249
9.3 Integral relation 252
9.4 Associated thermoelastic polynomials 254

10 Moving discontinuity surfaces 257
10.1 Singular surfaces propagating in a thermoelastic medium; thermoelastic wave of order n ($\gtrless 0$) 257
10.2 Propagation of a plane shock wave in a thermoelastic half-space with one relaxation time 261
10.3 Propagation of a plane acceleration wave in a thermoelastic half-space with two relaxation times 270

11 Time-periodic solutions 280
11.1 Plane waves in an infinite thermoelastic body with two relaxation times 280
11.2 Spherical waves produced by a concentrated source of heat in an infinite thermoelastic body with two relaxation times 294
11.3 Cylindrical waves produced by a line heat source in an infinite thermoelastic body with two relaxation times 302
11.4 Integral representation of solutions and radiation conditions in the Green–Lindsay theory 310
11.4.1 Integral representations and radiation conditions for the fundamental solution in the Green–Lindsay theory 310
11.4.2 Integral representations and radiation conditions for the potential–temperature solution in the Green–Lindsay theory 314

12 Physical aspects and applications of hyperbolic thermoelasticity 321
12.1 Heat conduction 321
12.1.1 Physics viewpoint and other theories 321
12.1.2 Consequence of Galilean invariance 323
12.1.3 Consequence of continuum thermodynamics 325
12.2 Thermoelastic helices and chiral media 329
12.2.1 Homogeneous case 329
12.2.2 Heterogeneous case and homogenization 332
12.2.3 Plane waves in non-centrosymmetric micropolar thermoelasticity 333
12.3 Surface waves 336

12.4 Thermoelastic damping in nanomechanical resonators 339
12.4.1 Flexural vibrations of a thermoelastic Bernoulli–Euler beam 339
12.4.2 Numerical results and discussion 342
12.5 Fractional calculus and fractals in thermoelasticity 343
12.5.1 Anomalous heat conduction 343
12.5.2 Fractal media 346

13 Non-linear hyperbolic rigid heat conductor of the Coleman type 352
13.1 Basic field equations for a 1D case 352
13.2 Closed-form solutions 355
13.2.1 Closed-form solution to a time-dependent heat-conduction Cauchy problem 355
13.2.2 Travelling-wave solutions 358
13.3 Asymptotic method of weakly non-linear geometric optics applied to the Coleman heat conductor 366

REFERENCES 383

ADDITIONAL REFERENCES 392

NAME INDEX 404

SUBJECT INDEX 408