

Preface

The theory of thermoelasticity began in the first half of the nineteenth century and acquired the importance in the middle of this century. It is well recognized that this theory is of great practical utility in several new areas of engineering and technology such as acoustics, aeronautics, chemical, and nuclear engineering. During the last four decades, the theory has been in rapid progress, and now, it is one of the major disciplines of continuum mechanics wherein there is a vast scope for theoretical and practical research.

Remembering the utility of these theories, this book deals with some problems in the mathematical theories of thermoelasticity (Coupled and Generalized) and magnetothermoelasticity, and all these problems have been solved by eigenvalue methodology and presented in four chapters. The techniques of integral transforms such as Laplace and Fourier transforms as also Laplace–Fourier double integral transforms and normal mode analysis have been used in the basic equations to form a vector–matrix differential equation (with unknown variables in the transformed domain) which is then solved by eigenvalue methodology.

This book contains five chapters including one introductory chapter named Basic Ideas.

The first chapter is the introductory chapter containing basic ideas of stresses, strains, thermoelasticity, magnetothermoelasticity, and constitutive relations in between them.

In the second chapter, the rudiment discussions of vector–matrix differential equation and solution methodology in the theories and inversion of Laplace transform.

The third chapter contains one problem on classical coupled thermoelasticity which deals with the theory of coupled thermoelasticity in an isotropic elastic medium with cylindrical cavity under the dependence of modulus of elasticity on the reference temperature.

The fourth chapter contains four problems of generalized thermoelasticity.

The first problem is concerned with the thermoelastic interactions in an unbounded isotropic body with spherical cavity. Exact expressions for temperature distribution, stress, and displacement components are obtained in Laplace transform domain for three different cases:

- (i) A known functional thermal load is given to the surface of the spherical cavity which is also stress free.
- (ii) The surface is stress free and exerted a ramp-type heat punch and
- (iii) A ramp-type thermal load is given to the boundary surface which is maintaining a constant reference temperature.

A numerical approach is implemented for the inversion of Laplace transform in order to obtain the solution in physical domain. Finally, numerical computations of the stress, temperature, and displacement have been made and presented graphically.

The second problem of this chapter is concerned with the thermoelastic interactions in an unbounded body with a cylindrical hole in the context of Green-Naghdi [G-N Model II] theory. The fundamental equations have been written in the form of a vector-matrix differential equation in the Laplace transform domain and solved by the eigenvalue approach methodology. Two different cases arising in the study of wave propagation in an infinite medium are studied in detail by the examination of the nature of the solution in space-time domain for different conditions of the boundary surface.

The third problem of this chapter deals with the thermoelastic interactions due to instantaneous heat source in a homogeneous isotropic and unbounded rotating elastic medium in the context of generalized thermoelasticity [L-S Model]. Integral transform techniques are adopted, namely the Laplace transform for the time variable and the exponential Fourier transform for two of the space variables in the basic equations of the generalized thermoelasticity, and finally, the resulting equations are written in the form of a vector-matrix differential equation which is then solved by the eigenvalue approach. Exact expressions for the temperature distribution, thermal stresses, and displacement components are obtained in the Laplace-double Fourier transform domain. A numerical approach is implemented for the inversion of Laplace transform and double Fourier transforms in order to obtain the solution in physical domain.

The fourth problem of this chapter deals with two-dimensional problem for a half-space under the action of body force. A double integral transform (Laplace transform for time variable and Fourier transform for space variable) is used to obtain the expressions of stresses and temperature when surface is stress-free with assigned thermal shock.

Fifth chapter contains three problems. These problems deal with generalized magnetothermoelasticity.

The first problem is concerned with one-dimensional problem of generalized magnetothermoelasticity for a half-space. Laplace transform for time variable is used, and the resulting equations are written in the form of a vector-matrix differential equation. To get the solution in the transformed domain, we apply the method of eigenvalue approach. The inversion of Laplace transform is carried out numerically by Bellman method. Finally, numerical computations have been done for the expressions of displacement, temperature, stresses, and induced magnetic

field. Several figures characterizing these field variables in the form of graphs are presented.

The second problem of this chapter deals with the thermoelastic interactions of two-dimensional problem of generalized magnetothermoelasticity for a half-space in a rotating medium under constant magnetic and electric intensities. The normal mode analysis is used to obtain the expressions for displacements, temperature, stresses, and induced magnetic field.

The third or last problem of this chapter deals with a two-dimensional problem of a homogeneous isotropic perfectly conducting thick plate in the context of generalized magnetothermoelasticity [L-S model]. A double integral transform (Laplace transform for time variable and Fourier transform for space variable) is used, and the resulting equations are written in the form of a vector–matrix differential equation which is solved by the eigenvalue approach subjected to time-dependent compression under constant magnetic and electric intensities. The inversion of Laplace transform is carried out numerically by Zakian method. Finally, numerical computations have been done for the expressions of displacement, temperature, stresses, and induced electric and magnetic field. Several figures characterizing these field variables in the form of graphs are presented.

The book has been written for those whose interest is primarily in the applications of the problems of thermoelasticity and magnetothermoelasticity, which are the branches of continuum mechanics related to the properties of elasticity and plasticity. Further, the book is written for the research scholars who have a great interest in thermoelastic problems (generalized or coupled). The chapters of this book should, therefore, be accessible to a student well grounded in thermoelasticity. If the reader wishes to use the results of the theory, they may rapidly pick out the results of needs. The chapters are quite independent and may be read in any order. This book is very much applicable for the students from the different branches of engineering, especially in the fields of material science and nuclear engineering.

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