A STUDY OF WAVE PROPAGATION IN GENERALIZED THERMOELASTIC MATERIALS WITH VOIDS

PREFACE

The concept of waves is an integral part of our scientific culture and has nourished physicists and mathematicians, pure and applied alike, for centuries. Many important discoveries in physics, including quantum mechanics, have involved wave phenomena. The wave concept owes some of its scientific success to its mathematical tractability. Problems concerning voids play a vital role in the practical problems of geological and synthetic porous medium where the classical theory is inadequate. The theory of elastic materials with voids is concerned with the elastic materials consisting of a distribution of small pores (voids) which contains nothing of mechanical or energetic significance and is one of the most recent generalizations of classical theory of elasticity.

Most material undergoes appreciable change of volume when subjected to variations of the temperature. If the thermal expansion or contractions are not freely admitted, temperature gives rise to "thermal stresses". Conversely, a change of volume is attended by a change of the temperature. When a given element is compressed or dilated, theses volume changes are accompanied by heating and cooling respectively. The study of influence of temperature of an elastic solid upon the distribution of stress and strain, and of the inverse effect of the deformation upon the temperature distribution is the subject of the theory of "Thermoelasticity". There are two shortcomings in the theory of thermoelasticity introduced by Duhamel (1837) and Neumann (1855). First, the mechanical state of an elastic body has no effect on the temperature is not in accordance with the true physical experiments and secondly, the heat equation being parabolic predicts an infinite speed of propagation for the
temperature, a physically unrealistic phenomenon. The coupling between thermal and strain fields gives rise to the coupled theory of thermoelasticity. For static problems this coupling vanishes and thermal field become independent of the strain field.

Later on, generalized thermoelastic theories were introduced into the literature in order to eliminate the shortcomings of the classical dynamic thermoelasticity. By “Generalized Thermoelasticity”, we mean a “Hyperbolic Thermoelasticity” in which disturbances propagate with finite speeds. The classic theory of thermoelasticity is governed by wave type (hyperbolic) equations of motion and diffusive type (parabolic) equations for heat conduction. This implies that if a thermoelastic material is subjected to thermal and mechanical disturbances, the effects in both the temperature and deformations fields will be felt at infinite distances from the source of disturbance. This implies that the disturbance has an infinite velocity of propagation and this is true in both temperature and deformation since the two fields are coupled. This is physically unrealistic and has been overcome by modifying the Fourier law of heat conduction through a more fundamental approach based on thermodynamic considerations.

The original research work reported in this thesis entitled, “A study of wave propagation in generalized thermoelastic materials with voids.” has been supplemented with numerical examples and the computer simulated results are presented graphically, wherever possible. The study embodied in this thesis may be useful for ultrasonic non-destructive inspection of plates, large diameter pipes and health monitoring of ailing infrastructure.
Following papers based on the research work included in this thesis have been published / accepted / communicated for publication in the Journals mentioned against each of them.

1. Three-dimensional vibration analysis of a thermoelastic cylindrical panel with voids, 
   *International Journal of Solids and Structures* (Accepted).
   Available online [www.sciencedirect.com](http://www.sciencedirect.com).

2. Propagation of plane waves in a rotating generalized thermoelastic solid with voids, 
   *Mathematical Problems in Engineering* (Accepted).


5. Rayleigh surface waves in a rotating generalized thermoelastic half-space with voids, 
   *Applied Mathematics and Computations* (Communicated).

6. Plane wave propagation in a generalized thermoelastic solid with voids, 
   *International Journal of Applied Mechanics and Engineering* (Communicated).

A part of this work has also been published in *Proceedings of National Conference on, “Recent Advances in Innovative Materials”* (RAIM-2008), Excel India Publishers, New Delhi, pp. 283-287, 2008.