

Abstract

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Parametric Integral Formulas and Analytical Properties of the Thermoelasticity Theories

ABSTRACT All structural materials possess to a certain extent the property of elasticity. The theory of elasticity in its broad aspects, deals with studying the behaviour of elastic solids that possess the property of recovering their size and shape when the forces producing deformation are removed. In addition, thermoelasticity concerns with the effects of heat on the deformation and stresses in non-isothermal elastic bodies. Such disturbances in solids are of interest in many branches of Physics and Engineering. In recent years, considerable efforts have been devoted to the study of cracks and holes in solids this is due to their applications in industry. Most studies of crack problems are carried on using equations of the coupled uncoupled theories of thermoelasticity. In fact, all structures contain cracks, as manufacturing defects because of service loading, which can be either mechanical thermal. If the load is applied cyclically, the crack may grow in fatigue to a final fracture its size increases followed by a decrease in the residual strength of the structure. Finally, the rate of crack growth increases suddenly leading to a catastrophic structural failure. Structural materials can be classified into four basic categories: metals, polymers, ceramics and composites. Recently, composites had been defined as "it is that type of material that is composed of two more materials combined together on a macroscopic scale to find a useful third material". Metallic alloys and polymeric blends are not classified as composites because constituents are mixed on a microscopic basis these are regarded as homogeneous, for practical purposes. Composites take a considerable importance in industry as they are commonly used in several applications particularly in structure plates and beams. Many advances in the theory and applications of elasticity, thermal and mechanical stresses have been made in recent years. In the present work, the effect of applying mechanical and thermal stresses on homogeneous isotropic thermoelastic plates and on composite materials is studied. The thesis consists of an introduction and seven chapters. The former introduces the concepts of thermoelasticity, fracture mechanics and composite materials. The first chapter displays the theoretical approach and literature survey to the theories of elasticity and thermoelasticity as well as some important special functions and transformations. The second chapter deals with a problem for an infinite thermoelastic solid with an internal penny-shaped crack, which is subjected to prescribed temperature and stress distributions. The third chapter considers a problem for an infinite space with a finite linear opening crack (Mode-I) inside that medium. The crack is subjected to prescribed temperature and mechanical stress. The fourth chapter concerns with a two-dimensional problem of a half-space that is weakened by a cylindrical hole in the presence of a static heat source located at its coordinate's origin. The fifth chapter extends the work done in the previous chapter to solve the same problem but dynamically. In the sixth chapter, a dynamic treatment of a generalized thermoelastic problem of heat conduction is applied for a layered thin plate, which is exposed to a uniform thermal shock. The temperature, the components of displacement and stress distributions are presented graphically for all problems. The last chapter illustrates and summarizes the conclusion for the results obtained throughout the thesis.