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AN APPROXIMATION THEORY FOR THE IDENTIFICATION OF LINEAR THERMOELASTIC SYSTEMS*

I.G. ROSEN† AND CHIEN-HUA FRANK SU
Center for Applied Mathematical Sciences, Department of Mathematics
University of Southern California, Los Angeles, CA 90089

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Abstract. An abstract approximation framework and convergence theory for the identification of thermoelastic systems is developed. Starting from an abstract operator formulation consisting of a coupled second order hyperbolic equation of elasticity and first order parabolic equation for heat conduction, well-posedness is established using linear semigroup theory in Hilbert space, and a class of parameter estimation problems is then defined involving mild solutions. The approximation framework is based upon generic Galerkin approximation of the mild solutions, and convergence of solutions of the resulting sequence of approximating finite dimensional parameter identification problems to a solution of the original infinite dimensional inverse problem is established using approximation results for operator semigroups. An example involving the basic equations of one dimensional linear thermoelasticity and a linear spline based scheme is discussed and numerical results indicating how our approach might be used in a study of damping mechanisms in flexible structures are presented.

1. Introduction. In this paper we develop an abstract approximation framework and convergence theory for the identification of abstract linear thermoelastic systems. The inclusion of thermal effects in the dynamics of flexible structures has recently received an increased amount of attention as an area of research as a result of the problem of solar heating of large flexible spacecraft and the effect that it can have on the structure's vibrational modes and the subsequent design of efficient and effective control laws.

The approach we take here is somewhat different than the traditional one usually taken by other authors working in the area of thermoelasticity (see, for example, [4], [5], [9], [13]). Rather than starting with the mathematical formulation of the basic laws of continuum mechanics and thermodynamics and then linearizing to arrive at the so called basic equations of linear thermoelasticity, we consider an abstract operator formulation of these basic equations set in appropriately chosen infinite

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