In applied mechanics it is always necessary to understand the fundamental properties of a system in order to generate an accurate numerical model or to predict future operating conditions. These fundamental properties include, but are not limited to, the material parameters of a specimen, the boundary conditions inside of a system, or essential dimensional characteristics that define the system or body. However in certain instances there may be little to no knowledge about the systems conditions or properties; as a result the problem cannot be modeled accurately using standard numerical methods. Consequently, it is critical to define an approach that is capable of identifying such characteristics of the problem at hand. In this thesis, an inverse approach is formulated using proper orthogonal decomposition (POD) with an accompanying radial basis function (RBF) network to estimate the current material parameters of a specimen with little prior knowledge of the system. Specifically conductive heat transfer and linear elasticity problems are developed in this thesis and modeled with a corresponding finite element (FEM) or boundary element (BEM) program. In order to create the truncated POD-RBF network to be utilized in the inverse approach, a series of direct FEM or BEM solutions are used to generate a statistical data set of temperatures or deformations in the system or body, each having a set of various material parameters. The data set is then transformed via POD to generate an orthonormal basis to accurately solve for the desired material characteristics using the Levenberg-Marquardt (LM) algorithm. For now, the LM algorithm can be simply defined as a direct relation to the minimization of the Euclidean norm of the objective Least Squares function(s).

The trained POD-RBF inverse technique outlined in this thesis provides an extensive means to which this inverse approach can be implemented into various fields of engineering and mechanics. More importantly this approach is designed to offer an inexpensive way to accurately estimate material characteristics or properties using nondestructive techniques. While the POD-RBF inverse approach outlined in this thesis offers primarily the development of conductive heat transfer and linear elasticity applications, this technique is designed to be directly applicable to other realistic conditions and/or industries.

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The public is welcome to attend.