The solution of two-dimensional inverse heat conduction problems by using two methods: Finite difference method and Duhamel Integral method

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Abstract

In this paper we present a new simple method consists the matrix form of Duhamel's principle for solving two-dimensional IHCP using temperature data containing significant noise and comparative this method with the numerical algorithm based on finite-difference method and the least-squares scheme for solving the inverse problem. The measurements ensure that the inverse problem has a unique solution, but both of these methods solution is unstable hence the problem is ill-posed. This instability is overcome using the Tikhonov regularization method with the gcv criterion for the choice of the regularization parameter.

Keywords: Two-dimensional inverse heat conduction problem, Duhamel's theorem, Tikhonov regularization method, SVD method

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1 Introduction

Inverse heat conduction problems (IHCPs) have been extensively studied over the last 60 years. They have numerous applications in many branches of science and technology. The problem consists in determining the temperature and flux heat at inaccessible parts of the boundary of a 2 or 3-dimensional body from corresponding data on accessible parts of the boundary. It is well-known that IHCPs are severely ill-posed which means that small perturbations in the data may cause extremely large errors in the solution.

The inverse problem is to find one part of the boundary conditions in two-dimensional body while the temperature measurements at the other part are given.

For $Q = \{(x, y, t) : x \in (0, 1), y \in (0, 1), t \in (0, t_M)\}$, the dimensionless mathematical formulation of two-dimensional IHCP may be expressed as follows:

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