

INVERSE DETERMINATION OF SPATIALLY VARYING HEAT CAPACITY AND THERMAL CONDUCTIVITY IN ARBITRARY 2D OBJECTS

Sohail R. Reddy, George S. Dulikravich and S. M. Javad Zeidi

*Department of Mechanical and Materials Engineering, MAIDROC Laboratory

Florida International University, Miami, Florida, USA

Email: sredd001@fiu.edu, dulikrav@fiu.edu, szeit001@fiu.edu

ABSTRACT A methodology for non-destructive simultaneous estimation of spatially varying thermal conductivity and heat capacity in 2D solid objects was developed that requires only boundary measurements of temperatures. The spatial distributions were determined by minimizing the normalized sum of the least-squares differences between measured and calculated values of the boundary temperatures. Computing time was significantly reduced for the entire inverse parameter identification process by utilizing a metamodel created by an analytical response surface supported by an affordable number of numerical solutions of the temperature fields obtained by the high fidelity finite element analyses. The minimization was performed using a combination of particle swarm optimization and the BFGS algorithm. The methodology has shown to accurately predict linear and nonlinear spatial distributions of thermal conductivity and heat capacity in arbitrarily shaped multiply-connected 2D objects even in situations with noisy measurement data thus proving that it is robust and accurate. The current drawback of this method is that it requires an a priori knowledge of the general spatial analytic variation of the physical properties. This can be remedied by representing such variations using products of infinite series such as Fourier or Chebyshev and determining correct values of their coefficients.