Preconditioned Iterative Methods For Sinc-Galerkin Systems From Certain Second-Order Partial Differential Equations

Zhong-Zhi Bai

State Key Laboratory of Scientific/Engineering Computing, Institute of Computational Mathematics and Scientific/Engineering Computing, Academy of Mathematics and Systems Science, Chinese Academy of Sciences, P.O. Box 2719, Beijing 100080, P.R. China

bzz@lsec.cc.ac.cn

When the Newton method or the fixed-point method is employed to solve the systems of nonlinear equations arising in the Sinc-Galerkin discretization of certain time-dependent partial differential equations, in each iteration step we need to solve a structured subsystem of linear equations iteratively by, for example, a Krylov subspace method such as the preconditioned GMRES. Also, in the discretization of separable second-order self-adjoint elliptic boundary value problem, the resulting linear system of equations is needed to be solved. In this presentation, based on the tensor and the Toeplitz structures of the linear systems we construct structured preconditioners for their coefficient matrices and estimate the eigenvalue bounds of the preconditioned matrices under certain assumptions. Numerical examples are given to illustrate the effectiveness of the proposed preconditioning methods. It has been shown that a combination of the Newton/fixed-point iteration with the preconditioned GMRES method is efficient and robust for solving the systems of nonlinear equations arising from the Sinc-Galerkin discretization of the time-dependent partial differential equations.