ABSTRACT

A spectral element method is proposed for the solution of elliptic problems defined in rectangularly decomposable domains. In our problem the domain is broken into a number of subdomains and the solution is approximated by a truncated expansion local to that domain. The expansion coefficients are determined by matching the solution and one its derivatives across the interfaces of contiguous domains. The thesis is summarized as follows.

Chapter 1 contains a description of some of the properties of Fourier series and orthogonal polynomial expansions. Spectral methods are introduced with emphasis on the choice of approximating functions, formulation of the method, domain decomposition techniques and a discussion of the treatment of singularities. The Galerkin version of the spectral method is described.

Chapter 2 consists of the implementation of the spectral method for the solution of Poisson's equation in rectangularly decomposable geometry, namely the T- shaped geometry. The domain is divided into semi–infinite and finite rectangular elements and the solution in each element is expressed in terms of the eigenfunctions of the differential operator with appropriate matching condition imposed across element interfaces. The effectiveness of eigenfunction expansion in achieving exponential convergence has been confirmed by using a Galerkin formulation of the matching condition to determine the unknown coefficients.

The representative geometry is complicated and has reentrant corner singularities, which are treated by a post–processing technique. The most novel feature of this technique detailed in chapter 3 is how an inharmonic part of the solution is constructed analytically such that the series solution possesses high rate of convergence even if the source term is not smooth. We conclude this study with some closing remarks in chapter 4.