ABSTRACT

The work presented in this thesis is on numerical schemes, optimal order *a priori* error estimates and computational experiments for fourth order differential equations using mixed Galerkin finite element methods. Two types of ordinary differential equations and two types of nonlinear time-dependent partial differential equations of fourth order in single space variable are considered.

A quadrature based mixed Petrov-Galerkin finite element method is applied to a special type of fourth order linear ordinary differential equation in divergence form. After employing a splitting technique, a cubic spline trial space and a piecewise linear test space are considered in the method. The integrals are then replaced by Gauss quadrature rule in the formulation itself. Optimal order *a priori* error estimates are obtained without any restriction on the mesh. The same method is then applied to a general fourth order linear ordinary differential equation and optimal order *a priori* error estimates are obtained without any restriction on the mesh. These error estimates are validated by a numerical example.

An H^1-Galerkin mixed finite element method is applied to the extended Fisher-Kolmogorov equation, a nonlinear time dependent fourth order partial differential equation, employing a splitting technique. This method may also be considered as a Petrov-Galerkin method with cubic spline space as trial space and piecewise linear space as test space, since second derivative of a cubic spline is a linear spline. Optimal order *a priori* error estimates are obtained without any restriction on the mesh. A fully discrete scheme is also developed and optimal order *a priori* error estimates are obtained. The results are validated with numerical examples.

A similar method is applied to the Kuramoto-Sivashinsky equation which is also a nonlinear time dependent fourth order partial differential equation. By employing a splitting technique, optimal order *a priori* error estimates are obtained without any restriction on the mesh. A fully discrete scheme is also discussed and optimal order *a priori* error estimates are obtained. The results are validated with numerical examples.