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Topic of Research: *High Accuracy Numerical Methods in Exponential form for the Solution of Non-linear Boundary Value Problems*

Summary of Abstract

Many physical problems can be modelled by partial differential equations, from applications as diverse as the flow of heat, the vibration of a ball, the propagation of sound waves, the diffusion of ink in a glass of water, the electric and magnetic fields, the spread of algae around the ocean's surface, the fluctuation in the price of stock option, and the quantum mechanical behavior of a hydrogen atom.

The aim of the thesis is to design high-accuracy compact difference schemes in exponential form for the solution of non-linear Boundary Value Problems (BVPs).

The thesis consists of six chapters. The chapter-wise summary is given herewith.

In **Chapter 1**, we do the groundwork which includes basic definitions and elementary results required for building up of thesis. In **Chapter 2**, we have derived a new third-order compact numerical method in exponential form for the numerical solution of the system of nonlinear two-point boundary value problems on a non-uniform mesh. In **Chapter 3**, a new compact exponentially fitted scheme using off-step grid has been presented for the numerical solution of second order two point non-linear BVPs. The detailed convergence analysis of the proposed scheme has been established via matrix analysis and graph theory. Moreover, the method is directly applicable to problems with singular coefficients. In **Chapter 4**, we have derived a new 9-point compact fourth-order numerical method in exponential form for the numerical solution of the system of 2D quasilinear elliptic partial differential equations. Many benchmark problems like Convection-diffusion equation, Poisson's equation in polar coordinates, Navier-Stokes equations of motion both in rectangular and polar coordinates, non-linear bi- and tri-harmonic equations, and quasi-linear elliptic equations have been solved and compared with the results of existing methods. In **Chapter 5**, we devise a novel exponential scheme, implicit in nature, using half-step discretization of order four for computing the numerical solution of quasilinear elliptic partial differential equations. Linear and nonlinear singular problems are tackled separately ensuring the usage of nine spatial grid points of a single computing cell. In **Chapter 6**, we have described a novel implicit method of order two in y and three in x-direction in exponential form,

by exploiting off-step discretization to solve numerically 2D non-linear elliptic partial differential equations in a rectangular region. The method is validated on several benchmark problems showing that formulation produces satisfactory results.