INTRODUCTION

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Restriction of various types of approximation (Padé and Taylor approximations) of functions is a new technique established in 1995 by Ismail and Elbarbary [15] .This restriction type is constructed by supposing a parameter to be determined such that the error is equal to zero at certain point of the domain of the function . If this parameter reduces to zero , we get back the classical approximations .Many problems and applications have been treated by this method giving almost exact solution.

Another category of methods for approximating the solution of PDEs is spectral collocation methods, which are described in many texts, for example, Canuto, et al.[4] . In these schemes, the solution is assumed to be a finite linear combination of some set of basis fuctions, and the function is discretized in the physical space at some chosen set of collocation points. The approximate solution is forced to satisfy the PDE only at the collocation points.

These schemes can be very efficient because the rate of convergence depends only on the smoothness of the solution. By contrast, in finite difference methods, the order of accuracy is fixed by the scheme .

In this thesis we introduce some contributions in these subjects considering initial boundary value problems in PDEs. This thesis consists of three chapters :

IN CHAPTER 1 we give a survey for approximation of functions , specially Padé, restrictive Padé approximations, spectral and pseudo-spectral methods .

IN CHAPTER 2 we apply the method of restrictive Padé to some new problems , showing implementations of the schemes, numerical examples are presented and the obtained results are compared with results of other classical methods.

The first test **:** we apply the method to a parabolic equation with complex coefficients through three example :

1- *the linear Schrödinger equation in one dimension:* a simple form is taken as a model problem , quoting a strategy that treats and solves the n×n complex tridiagonal matrices arisen. The method gave high accurate results compared with classical finite difference schemes. This subject is contained in our paper [17], 24th International Conference of Statistics & Computer Science, pp.51- 59, Cairo, (1999).

2- *two dimensional linear Schrödinger equation:* an implicit scheme for the solution of a given model problem is deduced and studied. This subject is contained in our paper [18], 24th International Conference of Statistics & Computer Science, pp.61-67, Cairo, (1999). The work done in [17] and [18] is presented in one paper [19] , 26th Int. Conference for Statistics and Computer Science and its Applications, pp.315-322,Cairo, (2001). Also this paper is published under the title "The Restrictive Padé Approximation for the solution of Schrödinger Equation " in International Journal of Computer Mathematics, Vol.79, No.5,pp. 603-613 (2002) [22].

3- *Schrödinger equation with potential as a function of position:* Two implicit finite difference schemes for the solution of Schrödinger equation with non-constant coefficients are established. The advantage of the method is illustrated by a numerical example. This subject is contained in our paper [21], 27th Int. Conference for Statistics and Computer Science and its Applications, Cairo, April, (2002).

The second test: we introduce a numerical treatment for the initial boundary value problem of the *singularly perturbed parabolic PDE* . We derive the finite difference schemes by applying the restrictive Padé approximation of matrix exponential . This subject is contained in our paper [20], 9th International Conference on Aerospace Sciences and Aviation Technology, Vol. I, pp.41-49, Cairo, (2001). Also this work is published in the Jour. Inst. Math. & Comp. Sciences, Vol.12 No.2 pp.153-161, (2001).

IN CHAPTER 3 we describe a new numerical method for solving two dimensional time dependent diffusion with non-local boundary condition by the pseudo-spectral approach .The method is based on Chebyshev matrix operators for differentiation and integration. Two numerical examples are given to test the method .