

Abstract

This study presents new numerical methods for solving differential/integral equations of interest in applications. This thesis consists of four parts. Part I presents numerical methods for solving ordinary differential equations exhibiting oscillatory solutions. This part proposes an adapted numerical integration based on exploiting a-priori known information about the behavior of the exact solution, employing some well-known numerical methods in combination with the technique of exponential fitting. The proposed method is shown to be highly effective in reducing error and improving the accuracy of the numerical solutions.

Parts II and III of this thesis present the numerical methods to solve Volterra integral and fractional integral/differential equations. To accomplish this, we provide effective numerical methods based on spectral methods and new orthogonal functions. The proposed methods are based on using special functions such as Chebyshev polynomials, Chelyshkov functions, and other orthogonal functions. The effectiveness of the proposed methods is examined by providing numerical experiments, which demonstrate the high accuracy and efficiency of the proposed methods. Additionally, the results of the proposed methods are compared with the existing methods, and it is shown that the proposed methods provide more accurate and efficient solutions for the problems considered in this thesis.

Keywords: Exponential fitting, Spectral methods, Ordinary differential equations, Volterra integral equations, Fractional integral/differential equations.