EXISTENCE AND STABILITY ANALYSIS FOR NON-LINEAR BOUNDARY VALUE PROBLEM INVOLVING CAPUTO FRACTIONAL DERIVATIVE

Kanika Dhawan[1], Ramesh Kumar Vats[1], Sachin Kumar Verma[2], and Avadhesh Kumar[3]

[1]Department of Mathematics & Scientific Computing
National Institute of Technology Hamirpur, HP-177005, India
[2]Department of Mathematics
Govt. College for Women Bawani Khera, Bhiwani (HR)-127032 India
[3] School of Advanced Sciences
VIT-AP University, Andhra Pradesh-522237, India

Abstract. In this manuscript, we will investigate existence, uniqueness and stability for the mixed boundary value problem involving Caputo's fractional derivative. A set of sufficient conditions are established for the concerned fractional order boundary value problem. We obtained these sufficient conditions by utilizing Banach Contraction Principle and Scheafer's Fixed Point Theorem. To justify the existence and uniqueness results, we give some illustrative examples. Furthermore, Ulam's stability of the concerned problem is demonstrated through MATLAB graphs.

Keywords. Caputo derivative, Fractional boundary value problem, Fixed point theorems, Existence and Uniqueness, Ulam's-Hyers stability.

AMS (MOS) subject classification: Primary 26A33; Secondary 34B15

1 Introduction

In many applications, real-world phenomena are modeled more accurately by Fractional Differential Equations (FDEs) rather than the ordinary differential equations [13]. FDE is a rapidly growing area in both practical as well as theoretical applications are concerned. The theory of the existence of solutions to nonlinear boundary value problems corresponding to fractional order differential equations have recently been attracted the attention of many researchers, for more details, we refer the reader to [2, 14]. FDEs occur more frequently in different research areas and engineering, such as aerodynamics, chemistry, control of dynamical systems, electrodynamics of complex medium, physics, polymer rheology etc [3, 6, 7]. Due to these features, models of FDEs become more practical and realistic than the models of integer-order [8, 11, 12, 15, 17]. The subject of existence and uniqueness of solutions of fractional differential equations were discussed in [18–23].