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ULAM-TYPE STABILITY OF HIGHER-ORDER NONLINEAR IMPULSIVE FRACTIONAL DIFFERENTIAL EQUATIONS

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Abstract. In this paper, we study four different types of Ulam stability (Hyers-Ulam stability, generalized Hyers-Ulam stability, Hyers-Ulam-Rassias stability, and generalized Hyers-Ulam-Rassias) for higher-order nonlinear impulsive fractional differential equation. Moreover, the paper provides a proof of the generalized Hyers-Ulam-Rassias stability by applying the generalized Diaz-Margolis fixed point theorem.

Keywords. Fractional differential equation; CaputoâĂŹs fractional derivative; Ulam stability; higher-order, fixed point theorems.

AMS (MOS) subject classification: 34A08, 34B10, 34B15, 26D10.

1 Introduction

Fractional differential equations have received significant attention in recent times. This research has explored various aspects, including the theoretical aspects of solution existence and uniqueness, as well as the development of analytic and numerical methods for solving such equations. Fractional differential equations have demonstrated their value as modeling tools in diverse fields such as engineering, physics, mechanics, chemistry, economics, and biology ([6], [11], [12], [17]). For those interested in delving into the theory of fractional calculus, see the references ([1], [2], [14], [16], [17], [18], [19]).

The analysis of nonlinear system stability has recently seen the inclusion of fractional calculus, and many problems have been investigated in this context.

In 1940, Ulam delivered a speech at the University of Wisconsin in which he introduced the concept of stability for functional equations. Ulam raised a question: "under what conditions does there exist an additive mapping near an approximately additive mapping ?". The first answer to UlamâĂŹs