Dynamics of Continuous, Discrete and Impulsive Systems Series A: Mathematical Analysis 29 (2022) 63-76 Copyright ©2022 Watam Press

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## EXISTENCE AND ULAM STABILITY FOR NONLINEAR CAPUTO-HADAMARD FRACTIONAL DIFFERENTIAL EQUATIONS WITH THREE-POINT BOUNDARY CONDITIONS

Adel Lachouri<sup>1</sup>, Abdelouaheb Ardjouni<sup>2</sup> and Ahcene Djoudi<sup>1</sup>

<sup>1</sup>Applied Mathematics Lab, Department of Mathematics University of Annaba, P.O. Box 12, Annaba 23000, Algeria

 $^2 \rm Department$  of Mathematics and Informatics University of Souk Ahras, P.O. Box 1553, Souk Ahras, 41000, Algeria

**Abstract.** In this paper, we use the fixed point theory to obtain the existence and uniqueness of solutions for fractional differential equations with three-point boundary conditions. Also, we show the Ulam stability of the solutions. Finally, an example is given to illustrate this work.

**Keywords.** Fractional differential equations, existence, uniqueness, Ulam stability, fixed point theorems.

AMS (MOS) subject classification: 26A33, 34A08, 34B15, 34K20.

## 1 Introduction

The concept of fractional calculus is a generalization of the ordinary differentiation and integration to arbitrary non integer order. Fractional differential equations with and without delay arise from a variety of applications including in various fields of science and engineering such as applied sciences, practical problems concerning mechanics, the engineering technique fields, economy, control systems, physics, chemistry, biology, medicine, atomic energy, information theory, harmonic oscillator, nonlinear oscillations, conservative systems, stability and instability of geodesic on Riemannian manifolds, dynamics in Hamiltonian systems, etc. In particular, problems concerning qualitative analysis of linear and nonlinear fractional differential equations with and without delay have received the attention of many authors, see [1]–[25], [27]–[29] and the references therein. The study of Ulam stability for fractional differential equations was initiated by Wang et al. [28]. An overview on the development of theory of the Ulam-Hyers and the Ulam-Hyers-Rassias stability for fractional differential equations can be found in [28, 29] and the references given therein. Subsequently, many authors discussed various Ulam-Hyers stability problem for different kinds of fractional