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A STUDY OF NONLOCAL INTEGRO-MULTI-POINT BOUNDARY VALUE PROBLEMS OF SEQUENTIAL FRACTIONAL INTEGRO-DIFFERENTIAL INCLUSIONS

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Abstract. We develop the existence criteria for the solutions of Caputo type sequential fractional integro-differential inclusions equipped with nonlocal multi-point boundary conditions involving Riemann-Liouville integral of fractional-order. We take into account the convex and non-convex multivalued maps in our analysis and make use of fixed point theorems for multivalued maps to establish the desired results.

Keywords. Sequential fractional derivative; inclusions; multi-point; integral boundary conditions; fixed point.

AMS (MOS) subject classification: 34A60; 34A08, 34B15.

1 Introduction

In this paper, we study the existence of solutions for a nonlocal integro-multi-point boundary value problem of sequential fractional integro-differential inclusions given by

$$({}^cD^q + k\ {}^cD^{q-1})x(t) \in F(t, x(t), {}^cD^\beta x(t), I^\gamma x(t)), \quad t \in [0,1], \quad 2 < q \leq 3, \tag{1}$$

$$x(0) = 0,\ x'(0) = 0,\ \sum_{i=1}^{m} a_i x(\zeta_i) = \lambda \int_0^\eta \frac{(\eta - s)^{\delta-1}}{\Gamma(\delta)} x(s)ds,\ \delta > 0, \tag{2}$$

where ${}^cD^{(.)}$ denotes the Caputo fractional derivative of order (.) , $I^{(.)}$ denotes the Riemann-Liouville integral of fractional order (.), $F : [0,1] \times R^3 \to \mathcal{P}(R)$ is a multivalued map, $\mathcal{P}(R)$ is the family of all nonempty subsets of R, $0 < \beta,\ \gamma < 1, k > 0, 0 < \eta < \zeta_1 < \cdots < \zeta_m < 1$ and $\lambda,\ a_i, i = 1, \ldots, m$ are real constants.