Sequential Initial Value Problems with Delay

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Abstract: In this paper, we discuss the solvability of a nonlinear Riemann-Liouville sequential initial value problem with infinite delay. We give sufficient conditions for the existence, uniqueness and stability of solutions. Proofs are carried out employing fixed point theory.

1 Introduction

In the last few centuries, non-integer order derivatives were widely expanded as a useful theoretical concept and numerous books were devoted to this field, see monographs [21, 24, 26]. Due to their nonlocal nature, fractional derivatives play a significant role in describing physical phenomena with memory effect and hereditary processes. Hence, they give better accuracy when compared to classical derivatives, the evidence of which has been provided for instance in [3] by virtue of numerical simulations. Consequently, more study has been conducted on new classes of fractional differential equations. In particular, fractional differential equations with time delay were capable to attract the attention of many researchers over the last few years, see [1, 4, 6, 7, 9], and the references therein.

Very recently, sequential fractional differential equations have been the subject of many investigations. Sequential fractional derivatives were introduced for the first time by Miller and Ross in their book [24]. As a matter of fact, they appear often in physics, where the substitution of formulas containing derivatives for one another is

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