

Solvability of Nonlinear Coupled Systems Including Katugampola Fractional and p -Laplacian Operators

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Abstract

We consider a coupled system of nonlinear fractional differential equations involving the Katugampola fractional derivative of variable-order and the p -Laplacian operator on the interval $[0, 1]$. The system is studied together with fractional boundary conditions. The purpose of this work is to examine whether the system has solutions, and if so, under what conditions those solutions are unique. To do this, the problem is transformed into an equivalent integral form using known properties of the Katugampola operator. Fixed-point methods are then applied to obtain the main results. We also investigate the Hyers–Ulam stability of the solutions, which shows that the solutions remain stable when small changes are made to the equation. The results presented here extend known results on fractional differential equations and demonstrate that the Katugampola fractional derivative can be effectively used to study nonlinear coupled systems involving the p -Laplacian operator.

Keywords: Fractional derivatives; p -Laplacian operator; Variable-order Caputo–Fabrizio derivative; Boundary value problems; Hyers–Ulam Stability

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