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Approximation Approach to Periodic BVP for Mixed Fractional Differential Systems

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Abstract

A numerical–analytic technique is presented for approximation of solutions of coupled fractional differential equations (FDEs) with different orders of fractional derivatives and subjected to periodic boundary conditions. Convergent sequences of functions are constructed with limit functions satisfying modified FDEs and periodic conditions. They are solutions of the given periodic BVP, if the corresponding system of determined equations has a root. An example of fractional Duffing equation is also presented to illustrate the theory.

Keywords: system of fractional differential equations, periodic boundary condition, approximation of solution, fractional Duffing equation
2000 MSC: 34A08, 34K07, Secondary 34K28

1. Introduction

It is well-known that fractional differential equations cannot possess non-constant periodic solutions [3]. Thus it is natural to study instead periodic boundary problems (PBPs), where many results have been already achieved [11, 12]. On the other hand, there is a nice and effective numerical–analytic technique suggested in [5, 6, 7, 8, 9] for the investigation of existence and approximate construction of periodic solutions for ordinary differential equations (ODEs). Recently, we have extended this method in [2] to Caputo type FDEs with PBP [11, 13].

On the other hand, unlike to systems of first order ordinary differential equations, we can consider different lower orders in $(0, 1]$ of fractional derivatives

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