

A MODIFIED ANALYTICAL METHOD FOR SOLVING FUZZY FRACTIONAL FORM OF HELMHOLTZ EQUATIONS

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Abstract. In this paper, we solve fractional Helmholtz equations under uncertainty, which arise from wave models describing time-independent mechanical growth in space. We employ the Optimal Homotopy Asymptotic Transform Method, a combination of the Optimal Homotopy Asymptotic Method and Laplace transform, to achieve effective control over the convergence of the approximate series. Using the Caputo fractional derivative, we obtain analytical fuzzy approximate solutions for three fuzzy fractional differential equations, providing both upper and lower bounds in the fuzzy environment. Graphical analysis reveals a symmetry between the bounds and demonstrates the method's effectiveness, while error estimates confirm that the employed method achieves high accuracy with minimal iterations. The flexibility in controlling convergence parameters further supports the method's reliability and efficiency for solving fractional differential equations under fuzziness.

1. Introduction

The field of fractional calculus (FC) has attracted growing attention from researchers since 2001, largely due to its effectiveness in solving a variety of real-world biological and physical problems with high accuracy. The fractional differential operator provides a greater degree of flexibility, as it functions as an absolute operator. FC is widely applied across numerous areas of both pure and applied mathematics. In this regard, a substantial body of literature, including books and research articles, is available [17, 18, 22, 24, 30].

Physical models of real-world phenomena often involve some degree of uncertainty. Fuzzy sets have emerged as a powerful tool to represent this uncertainty through

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