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Approximations of Solutions for a Sobolev Type Fractional Order Differential Equation

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Abstract: In this paper, using semigroup theory and Banach fixed point theorem, we establish the existence and uniqueness of approximate solutions of nonlinear Sobolev type fractional order evolution equation in a separable Hilbert space. Also, we consider the Faedo-Galerkin approximations of solutions and prove some convergence results.

Keywords: *analytic semigroup; approximate solution; fractional differential equation; Faedo-Galerkin approximation; Sobolev type evolution equation.*

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1 Introduction

In recent few decades, researchers have developed great interest in fractional calculus due to its wide applicability in science and engineering. Tools of fractional calculus have been available and applicable to deal with many physical and real world problems such as anomalous diffusion process, traffic flow, nonlinear oscillation of earthquake, real system characterized by power laws, critical phenomena, scale free process, description of viscoelastic materials and many others. For more details about fractional calculus we refer to [3–5, 7, 10, 12, 13, 16, 18].

In the present paper, we study the convergence of the Faedo-Galerkin approximations of solutions to the nonlinear fractional order Sobolev type evolution equation

$$\begin{aligned} \frac{d^q}{dt^q}[u(t)+g(t,u(t))]+Au(t) &= f(t,u(t)),\ 0<t\le T\le\infty,\ 0<q\le 1,\\ u(0) &= \phi, \end{aligned} \tag{1}$$

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