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On Solutions to a Nonautonomous Neutral Differential Equation with Deviating Arguments

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Abstract: The main objective of this paper is to study solutions of a nonautonomous neutral differential equation of parabolic type with a deviating argument in an arbitrary Banach space. The main results are obtained by the Sobolevskiĭ-Tanabe theory of parabolic equations and the Banach fixed point theorem.

Keywords: *analytic semigroup; neutral differential equation; Banach fixed point theorem.*

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1 Introduction

A natural way of generalizing differential equations is allowing the unknown function to appear with different values of the argument. Thus, differential equations with a deviating argument are differential equations in which the unknown function and its derivative appear in different places of the argument. This type of equations arise in many fields such as the theory of automatic control, the theory of self-oscillating systems, the problems of long-term planning in economics, the study of problems related with combustion in rocket motion, a series of biological problems, and many other areas [2]. One of the important examples is the process in fuel injection system for high-speed diesel engines which can be modeled as differential equations with a deviating argument of neutral type (see [2]).

The purpose of this work is to study solutions of the following type of neutral equation in a Banach space $(X, \|\cdot\|)$:

$$\left.\begin{aligned} \frac{d}{dt}[u(t)+g(t,u(a(t)))]+A(t)u(t) &= f(t,u(t),u(h(u(t),t))),\ t>0; \\ u(0) &= u_0, \end{aligned}\right\} \tag{1}$$

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