



# EXISTENCE THEOREMS FOR FUNCTIONAL DIFFERENTIAL EQUATIONS IN BANACH SPACES

SGHIR A.

**ABSTRACT.** This paper concerns with the study of existence theorems for a general class of functional differential equations of the form

$$u'(t) = f(t, u \circ \gamma(t, \cdot)).$$

The obtained results generalize the retarded functional differential equations [5, 6, 8] and cover singular functional differential equations [1, 2, 4, 7, 9, 12].

## 1. INTRODUCTION

Let  $(E, |\cdot|_E)$  be a Banach space. For a fixed  $r > 0$ , we define  $\mathcal{C} = C([-r, 0]; E)$  to be the Banach space of continuous  $E$ -valued functions on  $J := [-r, 0]$  with the usual supremum norm  $\|\varphi\| = \sup_{\theta \in [-r, 0]} |\varphi(\theta)|_E$ .

For a continuous function  $u : \mathbb{R} \rightarrow E$  and any  $t \in \mathbb{R}$ , we denote by  $u_t$  the element of  $\mathcal{C}$ , defined by

$$u_t(\theta) = u(t + \theta), \quad \theta \in J.$$

For each  $(\sigma, a) \in \mathbb{R} \times \mathbb{R}_+^*$ , we consider

$$\Gamma_{\sigma, a} = \{ \gamma : [\sigma, \sigma + a] \times [-r, 0] \rightarrow [\sigma - r, \sigma + a] \text{ continuous functions such that} \\ \text{for all } \theta \in [-r, 0], s \in [0, a], \quad \gamma(\sigma, \theta) = \sigma + \theta \text{ and } \gamma(\sigma + s, 0) = \sigma + s \}.$$

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# Differential Equations In Banach Spaces

**Angelo Favini, Atsushi Yagi**



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Grigor'evich Kreĭn,1971 *Linear Equations in Banach Spaces* KREIN,2012-12-06 INTRODUCTION xiii 1 LINEAR EQUATIONS BASIC NOTIONS 3 2 EQUATIONS WITH A CLOSED OPERATOR 6 3 THE ADJOINT EQUATION 10 4 THE EQUATION ADJOINT TO THE FACTORED EQUATION 17 5 AN EQUATION WITH A CLOSED OPERATOR WHICH HAS A DENSE DOMAIN 18 6 NORMALLY SOLVABLE EQUATIONS WITH FINITE DIMENSIONAL KERNEL 22 7 A PRIORI ESTIMATES 24 8 EQUATIONS WITH FINITE DEFECT 27 9 SOME DIFFERENT ADJOINT EQUATIONS 30 10 LINEAR TRANSFORMATIONS OF EQUATIONS 33 TRANSFORMATIONS OF d NORMAL EQUATIONS 38 11 12 NOETHERIAN EQUATIONS INDEX 42 13 EQUATIONS WITH OPERATORS WHICH ACT IN A SINGLE SPACE 44 14 FREDHOLM EQUATIONS REGULARIZATION OF EQUATIONS 46 15 LINEAR CHANGES OF VARIABLE 50 16 STABILITY OF THE PROPERTIES OF AN EQUATION 53 17 18 UNDETERMINED EQUATIONS 62 19 INTEGRAL EQUATIONS 65 DIFFERENTIAL EQUATIONS 80 20 APPENDIX BASIC RESULTS FROM FUNCTIONAL

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