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Existence and Approximation of Solutions for Systems of First Order Differential Equations

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Abstract: The purpose of this paper is to present some general results concerning the existence of solutions for systems of differential equations. The existence results to be presented will be based on an effective procedure for constructing approximate solution. Namely, a numerical scheme using the Sinc function, in which it is shown that the solution converges exponentially. Furthermore, a numerical example and comparisons are presented to prove the validity of the suggested method.

Keywords: *fixed-point theory; numerical solutions; systems of differential equations; existence of solutions.*

Mathematics Subject Classification (2010): 26A33, 35F25, 35C10.

1 Introduction

In addition to its intrinsic mathematical interest, the theory of ordinary differential equations has extensive applications in many general fields, for instance, physics, chemistry, biology, economics and engineering. The existence and uniqueness of a solution to a first-order differential equation, given a set of initial conditions, is one of the most fundamental results of ordinary differential equations.

In this paper, we shall confine our discussion to systems of first order differential equations of the form

$$\begin{aligned} \tfrac{dx_1}{dt} &= F_1(x_1, x_2, ..., x_n, t), \\ \tfrac{dx_2}{dt} &= F_2(x_1, x_2, ..., x_n, t), \\ &\vdots \\ \tfrac{dx_n}{dt} &= F_n(x_1, x_2, ..., x_n, t), \end{aligned} \tag{1}$$

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