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# ON A BOUNDARY VALUE PROBLEM OF A SINGULAR DISCRETE TIME SYSTEM WITH A SINGULAR PENCIL

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**Abstract.** In this article, we study a boundary value problem of a class of singular linear discrete time systems whose coefficients are non-square constant matrices or square with a matrix pencil which has an identically zero determinant. By taking into consideration that the relevant pencil is singular, we provide necessary and sufficient conditions for existence and uniqueness of solutions. In addition, a formula is provided for the case of unique solutions and optimal solutions are studied for the cases of no solutions and infinite many solutions. Finally, based on a singular discrete time real dynamical system, numerical examples are given to justify our theory.

**Keywords** : singular, difference equations, system, non-square, matrix

## 1 Introduction

Linear discrete time systems (or linear matrix difference equations), are systems in which the variables take their value at instantaneous time points. Discrete time systems differ from continuous time ones in that their signals are in the form of sampled data. With the development of the digital computer, the discrete time system theory plays an important role in control theory. In real systems, the discrete time system often appears when it is the result of sampling the continuous-time system or when only discrete data are available for use. Discrete time systems have many applications in economics, physics, circuit theory and other areas. For example in finance, there is the very famous Leondief model, see [2], or the very important Leslie population growth model and backward population projection, see also [2]. In physics the Host-parasitoid Models, see [14]. Applications of absorbing Markov chains or the distribution of heat through a long rod or bar are other interesting applications suggested in [26]. Thus many authors have studied discrete time systems and their applications, see [1], [2], [3], [4], [5], [6], [7], [8], [9], [10], [11], [13], [15], [16], [17], [18], [19], [20], [21], [22], [24], [25], [26], [27], [28], [29].