

Article

# Mathematical and Statistical Aspects of Estimating Small Oscillations Parameters in a Conservative Mechanical System Using Inaccurate Observations

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**Abstract:** This paper selects a set of reference points in the form of an arithmetic progression for planning an experiment to evaluate the parameters of systems of differential equations. This choice makes it possible to construct estimates of the parameters of a system of first-order differential equations based on the reversibility of the observation matrix, as well as estimates of the parameters of a system of second-order differential equations describing vibrations in a mechanical system by switching to a system of first-order differential equations. In turn, the reversibility of the observation matrix used in parameter estimation is established using the Vandermonde formula. A volumetric computational experiment has been carried out showing how, with an increase in the number of observations in the vicinity of reference points and with a decrease in the step of arithmetic progression, the accuracy of estimates of the parameters of the analyzed system increases. Among the estimated parameters, the most important are the oscillation frequencies of a conservative mechanical system, which establish its proximity to resonance, and therefore, determine the stability and reliability of the system.

**Keywords:** reference points; experiment planning; Vandermonde determinant; matrix exponents; diagonal matrices

**MSC:** 60J28

**Citation:** Tsitsiashvili, G.; Gudimenko, A.; Osipova, M. Mathematical and Statistical Aspects of Estimating Small Oscillations Parameters in a Conservative Mechanical System Using Inaccurate Observations. *Mathematics* **2023**, *11*, 2643. <https://doi.org/10.3390/math11122643>

Academic Editors: Vladimir Rykov and Dmitry Erovinin

Received: 27 April 2023

Revised: 5 June 2023

Accepted: 8 June 2023

Published: 9 June 2023



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## 1. Introduction

In [1], an algorithm was constructed for estimating the parameters of a system of first-order ordinary differential equations by a large number of inaccurate observations in the vicinity of one selected point. We will further call such points reference points. Estimates of the solution of the system and its derivative at the reference point are constructed by the method of linear regression analysis. According to them, estimates of the system parameters are determined by the method of moments, and their consistency is proved. However, the development of this topic requires the selection of several reference points for estimating the parameters of a linear system of ordinary differential equations. Such a problem arises, for example, if the number of unknown parameters is greater than the number of equations in the system and if the order of the system is higher than the first.

The estimation of the parameters of a system of linear differential equations with constant coefficients based on inaccurate observations of its solution is of particular interest. The choice of reference points forming a finite arithmetic progression allows us, in this case, to construct ratios for evaluating the elements of the coefficient matrix, including the inverse matrix, the square root of the matrix, etc. [2–4]. At the same time, it turns out that the Vandermonde determinant plays the main role in the circulation of the matrices

# Statistical And Mathematical Aspects Of Pollution Problems

**D.F. Boesch, N.N. Rabalais**



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El-Shaarawi, 2012-12-06 This book contains the proceedings of a workshop Statistical Methods for the Assessment of Point Source Pollution held September 12-14 1988 at the Canada Centre for Inland Waters in Burlington Ontario Canada The objectives of the workshop were to advance the art science and application of statistical methods to current water quality issues by stimulating discussions and disseminating ideas and information The emphasis was on statistical problems associated with monitoring and controlling discharges from industries and municipalities and assessing the impact of these discharges on receiving water quality b provide a forum for managers engineers scientists and statisticians to present and discuss techniques for evaluating water quality data and planning monitoring activities c provide a published state of the art summary of the application of statistical methods for the assessment of point source discharges and their impact on water quality The papers contained in this volume cover a number of topics that are of concern not only for monitoring and assessing point source pollution but also for other environmental problems      **Environmental Quality and Residuals**

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In a global defined by information and interconnectivity, the enchanting power of words has acquired unparalleled significance. Their capability to kindle emotions, provoke contemplation, and ignite transformative change is truly awe-inspiring. Enter the realm of "**Statistical And Mathematical Aspects Of Pollution Problems**," a mesmerizing literary masterpiece penned with a distinguished author, guiding readers on a profound journey to unravel the secrets and potential hidden within every word. In this critique, we shall delve into the book's central themes, examine its distinctive writing style, and assess its profound impact on the souls of its readers.

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