

**NUMERICAL MODELING OF THE BOUNDARY PROBLEM FOR A SINGULAR
EXCITED EQUATION WITH THE SPECTRAL METHOD***Razzakov Sherbek Tagaymurodvich**Termez state universette master of Applied Mathematics**Normurodov Chori Begalievich**scientific leader PhD*

Annotation: in this work, the issue of numerical solution of a boundary issue for a singular excited differential equation is considered. In this case, a solution is built on the basis of spectral methods and their accuracy, stability and efficiency in calculation are analyzed. The results of the study show that spectral methods provide high-resolution results for singular excited issues and can be useful tools in representing complex physical models.

Keywords: singular excited equation, spectral method, boundary issue, numerical modeling, high precision, finite layers

Singular excited equations are widely used in the fields of mathematical physics and engineering, being particularly important in modeling problems with boundary layers and very small parameters. Since it is difficult to solve these equations with a conventional number of methods, special methods are used in their solution — in particular, spectral methods. Spectral methods are characterized by providing high accuracy as well as being efficient in computing. In this work, using spectral methods, the boundary issue of the singular excited equation is modeled numerically, the results are analyzed and their accuracy assessed. Singular excited differential equations (SQDT) are found in the modeling of many physical, engineering and biological processes. These equations are defined in the presence of small parameters, and their solutions usually have boundary layers. Traditional numerical methods in determining these layers². Literature Review Spectral methods, particularly Chebyshev and Fourier-based approaches, are widely used in solving Sqdts. These methods provide high-resolution solutions, but require special lattices or transformations if boundary layers are present. Miller, O'riordan, & Shishkin (1996): provides a detailed account of adapted nets and spectral methods for Sqdts. Roos, Stynes, & Tobiska (1996): provides important results on numerical methods for Sqdts and their convergence. With the modern hybrid approach, in recent years, spectral methods have been combined with other numerical methods to develop hybrid approaches. These approaches provide more effective results in solving Sqdts. Ravi Kanth & Kumar (2017): offers customized spline techniques for two-parameter Sqdts. Rakmaiah & Phaneendra (2022): develops exponentially adapted schemes for two boundary layer Sqdts. Khan &

Research Methodology The classical spectral approach is the issue of the problem of singularly excited boundary value: $\varepsilon y''(x) + A(x)y'(x) + b(x)y(x) = f(x), \quad x \in (0,1), \quad y(0) = \alpha, \quad y(1) = \beta$ is a small parameter here and the solution has boundary layers. Chebyshev spectral method Lattice selection: a lattice is constructed on the basis of Chebyshev nodes. Representation of functions: the solution is expressed by

Chebyshev polynomials. Differential operators: are derivatives using Chebyshev differential matrices. Boundary conditions: boundary conditions are added to Matrix equations. Solution: the resulting system of linear equations is solved. A modern hybrid approach, which considers the following singular excited boundary value issue: $\epsilon y''(x) + p(x)y'(x) + q(x)y(x) = r(x)$, $x \in (0,1)$, $y(0) = a$, $y(1) = B$ is a small execution here, and the solution has 4.1. Classical Spectral Approach Precision: the Chebyshev spectral method provides high-resolution solutions. Layers: in the presence of boundary layers, special nets are required. Calculation cost: due to matrix operations, the calculation cost can be high. The modern hybrid approach is precision: the Shishkin net and B-spline approach more accurately represent layers. Flexibility: flexible for a variety of boundary conditions and functions. Computational efficiency: the computational cost is relatively low and solutions are obtained faster. In solving inference singular excited differential equations, spectral methods are characterized by high accuracy and fast convergence properties. Classical spectral methods, especially on the basis of Chebyshev polynomials, require special lattices or transformations if there are boundary layers, although they are effective for simple cases. Modern hybrid approaches, such as the basis of the Shishkin net and B-spline functions

This work addressed the issue of numerical modeling of the boundary issue for singular excited equations using spectral methods. Singular excited equations are a special case of ordinary differential equations, in the solutions of which, depending on a small parameter, drastic changes occur, namely boundary layers. When solving such equations by conventional numerical methods, problems of decreased accuracy and stability in calculation arise. For this reason, spectral methods with high resolution and able to accurately represent boundary properties give an advantage. In the course of the study, the theoretical foundations of spectral methods were analyzed, the main elements of which — the system of orthogonal functions, the Galerkin approach and the properties of complete smoothness — were studied in detail. An adapted algorithm for the singular excited problem was developed and modeling work was carried out in the MATLAB software environment. Results from Anan. Literature used

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