

Robust numerical method for singularly perturbed differential equations having both large and small delay

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method

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Abstract

Purpose – The purpose of this study is to develop stable, convergent and accurate numerical method for solving singularly perturbed differential equations having both small and large delay.

Design/methodology/approach – This study introduces a fitted nonpolynomial spline method for singularly perturbed differential equations having both small and large delay. The numerical scheme is developed on uniform mesh using fitted operator in the given differential equation.

Findings – The stability of the developed numerical method is established and its uniform convergence is proved. To validate the applicability of the method, one model problem is considered for numerical experimentation for different values of the perturbation parameter and mesh points.

Originality/value – In this paper, the authors consider a new governing problem having both small delay on convection term and large delay. As far as the researchers' knowledge is considered numerical solution of singularly perturbed boundary value problem containing both small delay and large delay is first being considered.

Keywords Singularly perturbed, Small delay, Large delay, Fitted spline, ϵ -uniformly convergent

Paper type Research paper

1. Introduction

A differential equation is said to be singularly perturbed delay differential equation, if it includes at least one delay term, involving unknown functions occurring with different arguments, and also, the highest derivative term is multiplied by a small parameter. Such type of delay, differential equations play a very important role in the mathematical models of science and engineering, such as the human pupil light reflex with mixed delay type [1], variational problems in control theory with small state problem [2], models of HIV infection [3] and signal transition [4].

Any system involving a feedback control almost involves time delay. The delay occurs because a finite time is required to sense the information and then react to it. Finding the solution of singularly perturbed delay differential equations, whose application mentioned above, is a challenging problem. In response to these, in recent years, there has been a growing interest in numerical methods on singularly perturbed delay differential equations. The

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