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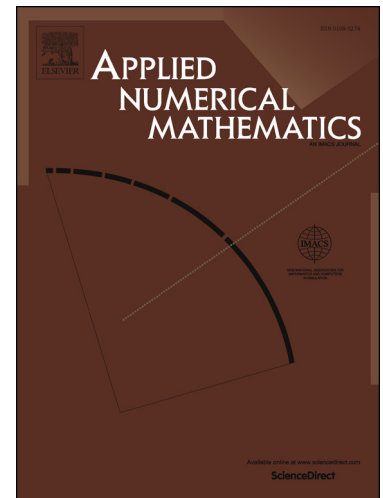
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Supercloseness of the continuous interior penalty method for singularly perturbed problems in 1D: vertex-cell interpolation [☆]

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Abstract

A continuous interior penalty method with piecewise polynomials of degree $p \geq 2$ is applied on a Shishkin mesh to solve a singularly perturbed convection–diffusion problem, whose solution has a single boundary layer. This method is analyzed by means of a series of integral identities developed for the convection terms. Then we prove a supercloseness bound of order $5/2$ for a vertex-cell interpolation when $p = 2$. The sharpness of our analysis is supported by some numerical experiments. Moreover, numerical tests show supercloseness clearly for $p \geq 3$.

Keywords: Singular perturbation, Convection–diffusion equation, Continuous interior penalty method, Shishkin mesh, Supercloseness

1. Introduction

We consider the following two-point boundary value problem

$$\begin{aligned} -\varepsilon u'' + b(x)u' + c(x)u &= f(x) \quad \text{in } \Omega := (0, 1), \\ u(0) = u(1) &= 0, \end{aligned} \tag{1}$$

with a positive parameter ε and sufficiently smooth functions b , c and f . There exist constants β and μ such that

$$b(x) > \beta > 0, \quad c(x) - \frac{1}{2}b'(x) \geq \mu > 0 \quad \text{for } x \in [0, 1], \tag{2}$$

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