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S.N. Jator, V. Manathunga

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Block Nyström type integrator for Bratu's equation

S. N. Jator*†, V. Manathunga†

*†Department of Mathematics and Statistics,
Austin Peay State University
Clarksville, TN 37044

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Abstract

In this paper, we use a Block Nyström Method (BNM) to obtain the numerical solution for one-dimensional Bratu's problem. The convergence analysis of the method is discussed and it is shown that the theoretical order of the method is consistent with its numerical rate of convergence. The accuracy benefit of the BNM is demonstrated by comparing it to several other known methods given in the literature. It is demonstrated that the BNM can also be used to solve Bratu's problem associated with initial conditions by simply adjusting the boundary conditions in the algorithm.

AMS Subject Classification: 65L06, 65L20

Key Words: Block Nyström method, One dimensions Bratu's equations, Convergence, Rate of convergence.

1 Introduction

Bratu's problem is defined as

$$\begin{aligned} \Delta y(x) + \lambda e^{y(x)} = 0, \quad & x \in \Omega, \\ y(x) = 0, \quad & x \in \partial\Omega, \end{aligned} \tag{1}$$

where $\lambda > 0$ and Ω is a bounded domain with boundary $\partial\Omega$. When we restrict to one dimension, where $\Omega = [0, 1]$ we can reduce the problem to

$$y'' + \lambda e^{y} = 0, \qquad y(0) = y(1) = 0, \qquad 0 \le x \le 1, \tag{2}$$

*Corresponding author. Email: Jators@apsu.edu