A new method for Lane-Emden type equation in terms of shifted orthonormal Bernestein polynomial

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Abstract

In this paper, we introduce shifted orthonormal Bernstein polynomials (SOBPs) and drive the operational matrix of integration of these functions. Then, we apply Galerkin method with numerical integration to solve linear and nonlinear Lane-Emden type singular initial value problems (IVPs). The idea of obtaining our algorithm is essentially based on converting the differential equation with its initial conditions to a system of linear or nonlinear algebraic equations. Numerical results with comparison are given to confirm the validity, efficiency and applicability of the method.

Keywords: shifted orthonormal Bernstein polynomials , operational matrix, Galerkin method with numerical integration
Mathematics Subject Classification [2010]: 13D45, 39B42

1 Introduction

Recently, the studies on (IVPs) for second order ordinary differential equations (ODEs) have been the focus of considerable attention. One of the second order equations describing this type of problem is the Lane-Emden singular IVPs, which can be written in the form of

$$y''(x) + \frac{\alpha}{x}y'(x) + f(x,y) = g(x), \alpha \geq 0,\ 0 \leq x \leq L, \tag{1}$$

subject to initial conditions

$$y(0) = A, y'(0) = B, \tag{2}$$

where A and B are constants, $f(x,y)$ is a continuous real valued function, and $g(x) \in C[0,L]$. In this study, a new method based on SOBPs defined on the interval $[0,L]$ is developed for approximate solution of the nonlinear differential equations of Lane-Emden type. Recently, some other approximate solutions of Lane-Emden equations are obtained [1, 2].

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