

Numerical Computation of Spectral Solutions for Sturm-Liouville Eigenvalue Problems**Sameh Gana****Department of Basic Sciences, Deanship of Preparatory Year and Supporting Studies, Imam Abdulrahman Bin Faisal University, P.O. Box 1982, Dammam, 34212, Saudi Arabia*** Corresponding author: sbgana@iau.edu.sa*

Abstract. This paper focuses on the study of Sturm-Liouville eigenvalue problems. In the classical Chebyshev collocation method, the Sturm-Liouville problem is discretized to a generalized eigenvalue problem where the functions represent interpolants in suitably rescaled Chebyshev points. We are concerned with the computation of high-order eigenvalues of Sturm-Liouville problems using an effective method of discretization based on the Chebfun software algorithms with domain truncation. We solve some numerical Sturm-Liouville eigenvalue problems and demonstrate the efficiency of computations.

1. Introduction

The Sturm-Liouville problem arises in many applied mathematics, science, physics and engineering areas. Many biological, chemical and physical problems are described by using models based on Sturm-Liouville equations. For example, problems with cylindrical symmetry, diffraction problems (astronomy) resolving power of optical instruments and heavy chains. In quantum mechanics, the solutions of the radial Schrödinger equation describe the eigenvalues of the Sturm-Liouville problem. These solutions also define the bound state energies of the non-relativistic hydrogen atom. For more applications, see [1], [2] and [3].

In this paper, we consider the Sturm-Liouville problem

$$-\frac{d}{dx}\left[p(x)\frac{d}{dx}\right]y + q(x)y = \lambda w(x)y, a \leq x \leq b, \quad (1.1)$$

$$c_a y(a) + d_a y'(a) = 0, \quad (1.2)$$

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