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Recurrence relations for the coefficients in series expansions with respect to semi-classical orthogonal polynomials

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Abstract

Let $\{P_k\}$ be a sequence of the semi-classical orthogonal polynomials. Given a function f satisfying a linear second-order differential equation with polynomial coefficients, we describe an algorithm to construct a recurrence relation satisfied by the coefficients $a_k[f]$ in the Fourier expansion

$$f = \sum_k a_k[f] P_k.$$

A systematic use of basic properties (including some non-standard ones) of the polynomials $\{P_k\}$ results in obtaining a recurrence of possibly low order. Recurrences for connection or linearization coefficients related to the first associated generalized Gegenbauer, Bessel-type and Laguerre-type polynomials are given explicitly.