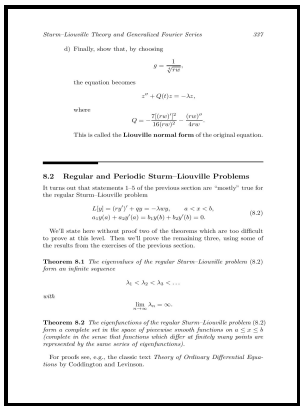
Boundary value problem of ordinary self-adjoint differential equations with singularities.

- - Some simple boundary value problems with corner singularities and boundary layers



Sturm–Liouville Theory and Generalized Fourier Series 227

d) Finally, show that, by choosing

$$\ell = \frac{1}{\sqrt{rw}},$$

the equation becomes

$$z'' + Q(t)z = -\lambda z,$$

where

$$Q = -\frac{7[(rw)']^2}{16(rw)^2} - \frac{(rw)''}{4rw}.$$

This is called the **Liouville normal form** of the original equation.

8.2 Regular and Periodic Sturm–Liouville Problems

It turns out that statements 1–5 of the previous section are "mostly" true for the regular Sturm–Liouville problem

$$L[y] = (ry')' + qy = -\lambda wy, \qquad a < x < b,$$
$$\alpha_1 y(a) + \alpha_2 y'(a) = h_1 y(b) + h_2 y'(b) = 0. \tag{8.2}$$

We'll state here without *proof* two of the theorems which are too difficult to prove at this level. Then we'll prove the remaining three, using some of the results from the exercises of the previous section.

Theorem 8.1 *The eigenvalues of the regular Sturm–Liouville problem* (8.2) *form an infinite sequence*

$$\lambda_1 < \lambda_2 < \lambda_3 < \dots$$

with

$$\lim_{n\to\infty} \lambda_n = \infty.$$

Theorem 8.2 *The eigenfunctions of the regular Sturm–Liouville problem* (8.2) *form a complete set in the space of piecewise smooth functions on* $a \le x \le b$ *(complete in the sense that functions which differ at finitely many points are represented by the same series of eigenfunctions).*

For proofs see, e.g., the classic text *Theory of Ordinary Differential Equations* by Coddington and Levinson.

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Sadovnichii, On Boundary-Value Problems for a Nonlinear Equation of the Theory of Gravitation, Moscow State University Press, Moscow 1986. Kiguradze IT, Chanturia TA: Asymptotic properties of solutions of nonautonomous ordinary differential equations, Mathematics and Its Applications Soviet Series. Restricting to boundary value problems formed by differential operators and avoiding the use of pseudo-differential operators makes the book accessible for a wider readership.

A Boundary Value Problem of Ordinary Self

Memoirs on Differential Equations and Mathematical Physics 2004, 31: 101—107. Results of the general theory are illustrated by concrete examples. Kiguradze I, Půža B, Stavroulakis IP: On singular boundary value problems for functional differential equations of higher order.

Elliptic Boundary Value Problems in Domains with Point Singularities

Non-self-adjoint operators arise in the discussion of processes that proceed without conservation of energy: in problems with friction, in the theory of open resonators, in problems of inelastic scattering, and others. Waltman, Nonlinear Two-Point Boundary-Value Problems, Academic Press, New York 1968.

Singular boundary

Results of the general theory are illustrated by concrete examples.

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Kiguradze I: On two-point boundary value problems for higher order singular ordinary differential equations.

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