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## THE STURM-LIOUVILLE THEORY AND FOURIER ANALYSIS

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**Abstract:** According to the Sturm-Liouville Theory, the eigenfunctions of a self adjoint linear differential operator of second order form an infinite sequence which is orthogonal and complete in  $L^2$ . Thus, depending on the choice of the differential operator and the boundary conditions, we obtain an assortment of bases for  $L^2$ . This provides a convenient approach for expanding any function in  $L^2$  in terms of these eigenfunctions. It turns out that the classical Fourier series expansion on  $(-\pi, \pi)$  in terms of  $\sin nx$  and  $\cos nx$  is the result of choosing the differential operator to be  $d^2/dx^2$ , with appropriate boundary conditions. For other choices we arrive at a more generalized theory of Fourier series based on other orthogonal bases.