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THE STURM-LIOUVILLE THEORY AND FOURIER ANALYSIS

Mohammed Al-Gwaiz

Department of Mathematics,

[King Saud University](http://www.king.edu.sa), Riyadh

malgwaiz@KSU.EDU.SA

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.