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A Comprehensive Study of the Separation of Variables Technique for Differential Equations

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Abstract: *This paper aims to provide a comprehensive study of the variable separation technique and its applicability to various types of ordinary differential equations and Partial Differential Equations. The separation of variables is a fundamental and widely applicable technique for finding analytical solutions to certain types of differential equations arising in diverse fields such as physics, engineering, and applied mathematics. To obtain unique solutions by using boundary and initial conditionsthis technique has the crucial role. We explore the theoretical framework, illustrate the technique with detailed examples encompassing linear and nonlinear equations, and discuss the limitations and extensions of this method. Furthermore, we examine the connection between separation of variables and the generation of orthogonal functions and Sturm-Liouville theory, highlighting its significance in the broader context of mathematical analysis.*

Keywords: Variable Separation, Ordinary Differential Equation, Partial Differential Equation, Initial Value Problem, Boundary Value Problem

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