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Solving Non-Homogeneous Differential Equations by Using the Method of Undetermined Coefficients and Variation of Parameters.

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Abstract: *Non-homogeneous differential equations play a crucial role in modelling real-world phenomena across physics, engineering, and economics. Two classical analytical methods for solving such equations are the Method of Undetermined Coefficients and the Method of Variation of Parameters. This paper explores both techniques in detail, highlighting their theoretical foundations, computational procedures, and practical applications. While undetermined coefficients provide a straightforward approach for equations with specific forcing functions such as polynomials, exponentials, and trigonometric terms, variation of parameters offers a more general framework applicable to a wider class of functions. Comparative analysis demonstrates that undermined coefficients are efficient but limited in scope, whereas variation of parameters, though computationally intensive, ensures universality. Case studies illustrate the strengths and limitations of each method, providing insights into their relevance in applied mathematics and engineering contexts. The study concludes by emphasising the complementary nature of Undetermined Coefficients and Variation of Parameters, suggesting that a combined understanding of these methods is essential for advanced problem-solving in differential equations.*

Keywords*:* Non-Homogeneous Differential Equations, Method of Undetermined Coefficients, Variation of Parameters, Particular Integral, Complementary Function, Linear Differential Equations

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