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## AN ALTERNATIVE TO ITÔ'S FORMULA TO SOLVE LINEAR FINANCIAL STOCHASTIC DIFFERENTIAL EQUATIONS

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**Abstract.** In this paper, we present a method for solving many stochastic differential equations from finance in a very simple way without using the usual Itô's formula. Our approach is straightforward and relies on using a linear ordinary differential equation method. The apparent simplicity of this method makes it attractive and accessible to a wider audience. We illustrate our approach by deriving solutions of some well-known stochastic financial models like Vasicek, Cox-Ingersoll-Ross, Hull and White, Brownian bridge, among others.

**Keywords.** Stochastic differential equations, linear ordinary differential equation method, Itô's formula, Vasicek model, Cox-Ingersoll-Ross model, Hull and White model, Brownian bridge

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## 1 Introduction

Since the publication of the celebrated papers of Black and Scholes [4] and Merton [10], the field of financial mathematics has been a very active area of research. The sophisticated theory of stochastic differential equations (SDEs) with its long list of prerequisites of advanced mathematical tools can be undoubtedly intimidating for a new comer. The books that were available until the mid eighties on SDEs were quite advanced and were accessible only to the researchers in the field particularly to mathematicians. This motivated many authors, given the popularity and the demand of the subject, starting with Øksendal [12] and later Mikosch [11], Kuo [9] and Allen [1], to mention only a few, to make the subject of SDEs more accessible to a larger audience from finance and economics background. The goal of this article is in the spirit of these authors to popularize the subject and make it available to even advanced undergraduate students.

In this paper, we present a method which is nothing but the linear ordinary differential equation (ODE) method that yields a solution of many