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A new method for solving of a backward stochastic differential equations by using a basic functions

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Abstract
In this paper, we purpose a method for numerical solution of a backward stochastic differential equations driven by standard Brownian motion as follows:

$$\begin{cases} dX(s) = f(X(s))ds + g(X(s))dB(s), & s \in [0, T), \\ X(T) = p. \end{cases}$$

The method is stated by using the basic functions based on the block pulse functions. Finally, we show the method has a good degree of accuracy by using some examples.

Keywords and phrases: Block pulse functions; Backward stochastic differential equations.

1. Introduction

Let $B(t),\ t \geq 0$ be the standard Brownian that be a martingale process and Gaussian (see [2]). In process have many applications in mathematical finance, biology, medical, social, scienes, etc (see [1]).
In this artical, we consider the stochastic differential equation

$$\begin{cases} dX(s) = f(X(s))ds + g(X(s))dB(s), & s \in [0, T), \\ X(T) = p. \end{cases}$$

or

$$X(t) = p + \int_t^T f(X(s))ds + \int_t^T g(X(s))dB(s) \qquad 0 \leq t < T. \tag{1.1}$$

where $X(S)$ be a stochastic process and unknown and $f,\ g : [0, T) \to \mathbb{R}$.

This paper is organized as follows. In section 2, we state a essential theorem and the basic properties of the block pulse functions. Then, we introduce the concept of the stochastic integration operational matrix. In section 3, we solve Eq. (1) by using the stochastic integration operational matrix and collocation method. In section 4, we examine The proposed method with an example. Finally, Section 5, we give a brief conclusion.

2. Preliminaries

Theorem 2.1. *Let $f(x)$ be twice continuously differentiable function on $\mathbb{R}$, then for all $t \in (0, T]$*

$$df(B(t)) = f'(B(t))dB(t) + \frac{1}{2}f''(B(t))dt.$$