Available online at www.sciencedirect.com
ScienceDirect
Chaos, Solitons and Fractals 39 (2009) 1486–1492
CHAOS
SOLITONS & FRACTALS
www.elsevier.com/locate/chaos

Beyond Adomian polynomials: He polynomials

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Accepted 1 June 2007

Communicated by A. Helal

Abstract

The Adomian decomposition method is widely used in approximate calculation. The main difficulty of the method is to calculate Adomian polynomials, the procedure is very complex. In order to overcome the demerit, this paper suggests an alternative approach to Adomian method, instead of Adomian polynomials, He polynomials are introduced based on homotopy perturbation method. The solution procedure becomes easier, simpler, and more straightforward.

1. Introduction

The homotopy perturbation method (HPM) [1–8,17,18] has been extensively worked out over a number of years by numerous authors. Starting from some pioneering ideas going back to He [1] in 1999, it has matured into a fully fledged theory thanks to the efforts of many researchers, notably Ariel et al. [9], Beléndez et al. [10], Cveticanin [11], Ganji [12,13], Siddiqui et al. [14,15], Ozis and Yidirim [16] to mention only a few. The method has been shown to solve effectively, easily, and accurately a large class of nonlinear problems, generally one or two iterations lead to high accurate solutions. For a relatively comprehensive survey on the method and new interpretation, the reader is referred to the review article [17,18].

In our previous paper [19], the homotopy perturbation method is used to calculate Adomian polynomials, making the solution procedure in Adomian method remarkable simple and straightforward. It is well-known that the main disadvantage of the Adomian method is the complex and difficult procedure for calculation the so-called Adomian polynomials, there is an alternative approach to overcoming the demerit, that is, the variational iteration method [20–22]. In this paper, we will introduce He polynomials in order to make the solution procedure easier, more effective and more straightforward.

The Adomian method [23,24] is a technique for solving functional equations of various kinds in the form

$$u - N(u) = f, \tag{1}$$

where N is a nonlinear operator from Hilbert space H to H, u is an unknown function, and f is a known function in H. The Adomian method decomposes u as a series with components u_n, and $N(u)$ as a series with components A_n, Adomian's polynomials, which can be calculated using the formula:

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0960-0779/$ - see front matter
doi:10.1016/j.chaos.2007.06.034