Letter to the Editor

He's Max-Min Approach to a Nonlinear Oscillator with Discontinuous Terms

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Recently, the max-min approach was systematically studied in the review article (Ji-Huan, 2012). This paper concludes that He's max-min approach is also very effective for nonlinear oscillators with discontinuous terms.

The ancient Chinese mathematics revives modern applications [1–8]; hereby, we show that He's max-min approach [1, 9–11] is also very effective for nonlinear oscillators with discontinuous terms.

The max-min approach was first proposed in 2008 based on an ancient Chinese mathematics, and it has become a well-known method for nonlinear oscillators; see, for example, [12–14].

To illustrate the basic idea of the max-min approach [1], we consider the following nonlinear oscillator:

\[ u'' + \beta u^3 + \epsilon u |u| = 0, \quad u(0) = A, \quad u'(0) = 0. \]  

(1)

By a similar treatment as given in [1], we have

\[ 0 < \omega^2 < \beta A^2 + \epsilon A, \]  

(2)

where \( \omega \) is the unknown frequency.

According to an ancient Chinese inequality [1, 8, 10, 11], we have

\[ \omega^2 = \frac{n(\beta A^2 + \epsilon A)}{m + n} = k (\beta A^2 + \epsilon A), \quad k = \frac{n}{(m + n)}. \]  

(3)

where \( m, n, \) and \( k \) are constants.

According to He's max-min approach, we set

\[ \int_0^{T/4} \left( k (\beta A^2 + \epsilon A) u - \beta u^3 - \epsilon u |u| \right) \cos \omega t \, dt = 0, \]  

(4)

or

\[ -\epsilon A \cos \omega t |A \cos \omega t| \cos \omega t \, dt = 0, \]  

(5)

from which the frequency \( \omega \) can be determined approximately as

\[ \omega = \sqrt{\frac{3}{4} \beta A^2 + \frac{8}{3\pi} \epsilon A}, \]  

(6)

which is the same as that obtained by the homotopy perturbation method [15].

References


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