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Asymptotic methods for nonlinear vibrations of continuous systems

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ABSTRACT

The problem of nonlinear oscillations of continuous systems is an outstanding one in science and engineering. Its significant peculiarity is a phenomenon of internal resonance. The main difficulty in searching analytical solution is the problem of small denominators [1, 2].

We propose two new asymptotic methods for constructing periodic solutions.

Our first approach is valid for problems of small nonlinearity. From the conditions of secular terms absence we obtain infinite system of nonlinear algebraic equations. Then we introduce artificial small parameter in order to diagonalize this system, and the solution is searched in the form of corresponding asymptotic expansions. Finally, we use Pade approximants for truncation of obtained series.

The idea of our second approach was inspired by Bender et al. [3]. We introduce artificial small parameter delta into the exponent of the nonlinear term, so that it is a measure of nonlinearity of the problem. The solution is represented by asymptotic powers and logarithmic expansions in terms of delta. In this approach we get only one resonance term in each approximation. Another advantage of the proposed procedure is that one does not have to assume nonlinear terms in the governing equations to be small. We suppose that proposed novel methods are robust and can be an interesting alternative to the classical approach of the KAM theory.

References

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