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Mathematical Models of Nonlinear Oscillations of Mechanical Systems with Several Degrees of Freedom

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Abstract: A nonlinear dynamic system with several degrees of freedom, which is represented by a system of differential equations with polynomial structure, is considered. The system contains non-linear polynomials. It is assumed that the spectrum of the eigenvalues of the linear part matrix starts with a pair of complex conjugate eigenvalues having negative real parts with minimum modulus. A polynomial transformation of the equations is performed in order to simplify the mathematical model by reducing the number of non-linear terms in the differential equations. Nonlinear oscillations of an object with constant parameters are investigated. Estimations of motion are obtained by the method of differential inequalities for positive definite Lyapunov function at different ratios between the constant parameters of the system. An example is presented .

Keywords: *autonomous dynamical system; degrees of freedom; phase state variables; nonlinear oscillations; polynomial transformation of variables; Lyapunov function; differential inequality.*

Mathematics Subject Classification (2010): 74H45, 70K75, 70K05, 34C10, 34C15, 45G10, 41A10, 37B25, 34K13.

1 Introduction

The paper deals with nonlinear analysis in classical and modern mechanics [1–5].

We use a Poincare-Dulac approach [6–9] and consider a nonoscillatory nonlinear stationary mechanical system with one degree of freedom. The system has autonomous nonlinear polynomial characteristics associated with its phase variables. This fact leads to the linear form, alternative to the extended model method shown in [10].

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