

Comparative analysis of the theories of nano-mechanical systems on the example of contact interaction of nano-Bernoulli-Euler beams

Jan Awrejcewicz, Anton V. Krysko, Maxim V. Zhigalov, Vadim A. Krysko

Abstract: In this paper, for the problem of contact interaction of Bernoulli-Euler nanoblock, a comparative analysis of the most commonly used theories, i.e. modified couple stress theory, nonlocal theory and strain gradient theory have been employed. With the help of Hamilton's variational principle the resolving system of differential equations and the corresponding boundary conditions for each mathematical model are obtained. To solve the system of nonlinear differential equations, the second-order finite difference and fourth-order Runge-Kutta methods are applied. Fourier and wavelet analysis, phase portraits, pseudo Poincare maps, and dynamic analysis of the largest Lyapunov exponents are used to analyze the nonlinear dynamics of the contact interaction. In addition, the phase chaotic synchronization is investigated. With the help of the developed programs, the influence of the type of mathematical model on the deflection of the beam, estimation of both the natural frequencies and the types of modes of vibration of the beam are carried out.

-
- ¹⁾ Jan Awrejcewicz, Professor: Lodz University of Technology, Department of Automation, Biomechanics and Mechatronics, 1/15 Stefanowskiego Str., 90-924 Lodz, Poland (PL), jan.awrejcewicz@p.lodz.pl.
 - ²⁾ Anton V. Krysko, Professor: Department of Applied Mathematics and Systems Analysis, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, Russia (RU), anton.krysko@gmail.com.
 - ³⁾ Maxim V. Zhigalov, Professor: Department of Mathematics and Modeling, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, Russia (RU), zhigalovm@ya.ru.
 - ⁴⁾ Vadim A. Krysko, Professor: Department of Mathematics and Modeling, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, Russia (RU), tak@san.ru.