15th INTERNATIONAL CONFERENCE
Dynamical Systems — Theory and Applications
December 2-5, 2019. Lodz, POLAND.

DSTA 2019

paper id: VIB304

Contact interaction of NEMS elements composed of a plate/beam, taking into account the Casimir and Van der Waals forces and under additive white noise

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Abstract: A mathematical model of the contact interaction of a nanostructure, which is a nanoplate, supported by a nanobeam in its center, is constructed. There is a small clearance between the nanoplate and the nanobeam. An external alternating transverse distributed load and an external field of additive white noise act on the nanoplate. The noise component depends on the spatial variable of the mechanical nanostructure. Additive noise is added to the system of equations in the form of a random term with constant intensity. An electric field acts on the nanobeam (Casimir and Van der Waals forces). The nanoplate is described by the Kirchhoff kinematic model, and the Euler-Bernoulli nanobeam. To take into account nanoscale parameters, a modified moment elasticity theory proposed by Young is applied. The contact interaction between the elements of the plate-beam nanostructure is taken into account according to the Winkler model based on the Cantor's theory. Contact interaction leads to occurrence of a design nonlinearity of the nanostructure. The mathematical model of the nanostructure is developed taking into account the geometric nonlinearity according to the theory of von Karman. The system of equations is derived from the Hamilton's principle. The studies performed make it possible to consider problems as systems with an almost infinite number of degrees of freedom. The methods of the qualitative theory of differential equations are used to analyze the influence of the noise and electric fields on the contact interaction of a nanoplate and a nanobeam.

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