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Nonlinear dynamics of flexible nanobeams taking into account the Casimir, van der Waals and Coulomb forces

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Abstract: We construct a mathematical model of the flexible nano beam based on the Sheremetev-Pelekh kinematic model, subject to the following hypotheses: (i) the beam is elastic and isotropic; (ii) the nanostructure of the beam is described by the modified moment theory of elasticity; (iii) the beam is in a stationary temperature field, which is described by the Duhamel-Neumann model; (iv) geometric nonlinearity is taken into account by the von Karman model; (v) the Sheremet'ev-Pelekh kinematic model taking into account; (vi) the stationary temperature field is determined from the solution of the two-dimensional heat equation taking into account the internal heat sources (boundary conditions of the first-third kind); (vii) the influence of Casimir, van der Waals and Coulomb forces is taken into account. PDEs, boundary and initial conditions are yielded by the Hamilton principle. They are next reduced to the Cauchy problem by the finite differences method of the second order of accuracy. The Cauchy problem is solved by Runge-Kutta and Newmark methods. The convergence of the methods is investigated depending on the number of beam length partition intervals and boundary conditions. The effects of the velocity of the longitudinal waves, the size-dependent parameter, the Casimir, van der Waals and Coulomb forces, the intensity and nature of the temperature field, the amplitude and frequency of the transverse alternating load, geometric nonlinearity, kinematic models (first, second, third order approximation) are analyzed.

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