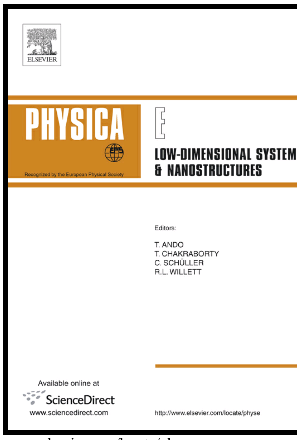

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Free vibration of fractional viscoelastic Timoshenko nanobeams using the nonlocal elasticity theory

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Abstract. In this article, the free vibration of a fractional viscoelastic Timoshenko nanobeam is studied through inserting fractional calculus as a viscoelastic material compatibility equations in nonlocal beam theory. The material properties of a single-walled carbon nanotube (SWCNT) are used and two solution procedures are proposed to solve the obtained equations in the time domain. The former is a semi-analytical approach in which the Galerkin scheme is employed to discretize the governing equations in the spatial domain and the obtained set of ordinary differential equations is solved using a direct numerical integration scheme. On the contrary, the latter is entirely numerical in which the governing equations of system on the spatial and time domains are first discretized using general differential quadrature (GDQ) technique and finite difference (FD) scheme, respectively and then the set of algebraic equations is solved to arrive at the time response of system under different boundary conditions. Considering the second solution procedure as the main approach, its validity and accuracy are verified by the semi-analytical approach which is more difficult to enter various boundary conditions. Numerical results are also presented to get an insight into the effects of fractional derivative order, nonlocal parameter, viscoelasticity coefficient and nanobeam length on the time response of fractional viscoelastic Timoshenko nanobeams under different boundary conditions.

Keywords: Timoshenko nanobeam; Viscoelasticity; Free vibration; Nonlocal theory; Fractional order

1. Introduction

To analyze the vibration, bending and buckling behaviors of some mechanical devices, they are modeled as a beam. Numerous studies on the linear and nonlinear vibrations of Euler-Bernoulli and Timoshenko beams have been carried out using analytical [1, 2] and numerical [3-5] methods in the open literature.

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