Boundary Characteristic Orthogonal Polynomials for free Vibration of Euler–Bernoulli Nanobeam exposed to Hygro-Magnetic Environment Embedded in Elastic Foundation

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Abstract

This research explores the vibration characteristics of a nanobeam subjected to a longitudinal magnetic field and linear hygroscopic environment, while embedded in a Winkler-Pasternak elastic foundation. The study utilizes the Boundary Characteristic Orthogonal Polynomials (BCOP)-based Rayleigh-Ritz method to study the vibration of the nanobeam. The nanobeam is modelled using Hamilton's principle, incorporating both the Euler-Bernoulli beam theory and Eringen's nonlocal elasticity theory. The derived governing equation of motion is used to compute non-dimensional frequency parameters. The BCOP shape functions are employed, taking advantage of their orthogonality, which helps to avoid system ill-conditioning even with a higher number of terms in the approximation. To validate the proposed model, a comparison with an existing model in special cases is performed, demonstrating excellent agreement. Additionally, a convergence analysis is conducted to assess the correctness and effectiveness of the employed method. Furthermore, a parametric study is carried out to investigate the influence of various characteristics, such as small-scale parameter, Winkler modulus, shear modulus, magnetic parameter, and hygroscopic parameter, on the frequency parameters. Overall, this research provides valuable insights into the vibration behaviour of nanobeams under the influence of magnetic fields and hygroscopic environments, offering a reliable and efficient numerical approach for the analysis.

Keywords

Boundary Characteristic Orthogonal Polynomials; Hygroscopic Environment; Euler–Bernoulli Nanobeam; Magnetic field; Vibration.