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Nonlinear Vibration Analysis of a Functionally Graded Micro-Beam under a Step DC Voltage

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Abstract : This paper presents vibration behavior of a FGM micro-beam and its pull-in instability under a nonlinear electrostatic pressure. An exponential function has been applied to show the continuous gradation of the properties along thickness. Nonlinear integro-differential-electro-mechanical equation based on Euler–Bernoulli beam theory has been derived. The governing equation in the static analysis has been solved using Step-by-Step Linearization Method and Finite Difference Method. Fixed points or equilibrium positions and singular points have been shown in the state control space. In order to find the response to a step DC voltage, the nonlinear equation of motion has been solved using Galerkin-based reduced-order model and time histories and phase portrait for different applied voltages have been shown. The effects of electrostatic pressure on stability of FGM micro-beams having various amounts of the ceramic constituent have been investigated.

Keywords : FGM, MEMS, nonlinear vibration, electrical, dynamic pull-in voltage
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