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Bifurcation behavior of a capacitive micro-beam suspended between two conductive plates

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In this paper, bifurcational and pull-in behavior of a capacitive micro switch suspended between two conductive stationary plates, have been studied. The dynamic motion equation of the micro-switch has been obtained using Euler Bernoulli beam theorem. Due to the nonlinearity of the electrostatic force, the analytical solution for the derived equation is not available. So the governing differential equation has been solved using combined Galerkin weighted residual and step-by-step linearization methods (SSLM).

To obtain the fixed points and study the local and global bifurcational behavior of the micro switch, a mass-spring model has been utilized and adjusted so that to have similar static/dynamic characteristics with those of Euler-Bernoulli beam model (in the first mode). Using 1-DOF model, mathematical and physical equilibrium points of the micro-switch have been obtained for three different cases. It is shown that the pull-in phenomenon in the present micro-switch can be occurred due to a pitchfork or transcritical bifurcations as well as saddle node bifurcation which are occurred in the classical micro-switches. And for some cases primary and secondary pull-in phenomena are observed where the first one is due to a transcritical bifurcation and the second one is due to a saddle node bifurcation. In addition the dynamic response of the switch to a step DC voltage has also been studied and the results show that in contrast to the classical micro-switches, the ratio of the dynamic pull-in voltage to the static one depends on the gaps and voltages ratio where for the classical one is approximately a constant value.

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Bifurcation and Stability Analysis of an Electrostatically Actuated Nano-beam

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This paper deals with the study of bifurcation behavior of a capacitive nano-beam considering electrostatic, Casimir and van der Waals forces. A modified mass-spring model has been implemented for analysis of the nano-beam behavior. The model has been adjusted and corrected with Euler-Bernoulli beam model, because of its less accuracy compared to distributed models. Fixed or equilibrium points of the nano-beam have been obtained, and has been shown that with variation of the applied voltage and the length of the nano-beam as control parameters the number of equilibrium points is changed. The stability of the fixed points has been investigated drawing motion trajectories in phase portraits and basins of attractions and repulsion have been illustrated. Critical values of the applied voltage and the length of the nano-beam leading to qualitative changes in the nano-beam behavior have been obtained.

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