ABSTRACT

The present research is a unique attempt to model a piezoelectric energy harvester by Variational Asymptotic Method (VAM). Vibration based energy harvesting has been an exciting topic of research over the last decade. The main motivation behind this research is finding alternate energy source for low power electronics and also utilization of daily otherwise unused energy. Piezoelectric materials are preferable because of their large power densities in energy harvesting applications. The most typical type of piezoelectric energy harvesters are of beam shape which generates voltage output from an ambient vibrational input. The major challenge in modelling of piezoelectric transducers lies in capturing the coupling effects both electromechanical coupling, as well as structural coupling. Full scale 3D FEM based analysis is capable of doing a coupled field analysis but they are computationally expensive, difficult to integrate with circuit analysis simulation; on the contrary dimensionally reduced models like the present one, makes a balance of computational efficiency, simplicity and 3D level accuracy. Currently, in literature the models existing for piezoelectric harvester fail to provide a reliable one-stop single solution methodology which can deal with all possible design parameters, related to geometry or material, like anisotropy, multilayer, geometrically linear as well as nonlinear, axial and shear mode harvester. The present work initiates with developing a coupled electromechanical theory based on Variational Asymptotic Method (VAM), a well-known dimensional reduction method, for modelling a piezoelectric beam type harvester which overcomes the above mentioned modelling limitations in a reduced order geometry. The model is also capable of capturing effect of structural coupling. The reliability of the developed mathematical model for energy harvester have been tested by its validation with the experiments. A detailed parametric analysis have been reported to highlight the wide ranging application potential.