MECHANICAL ENGINEERING STUDENT SEMINAR

Thursday, September 19th 2024 at 13:30, D. Dan and Betty Kahn Building, Room 217.
Online: https://technion.zoom.us/j/93713027759

Vibration of Cantilever Beams, with Application to Piezoelectric Vibrating Energy Harvester (PVEH) Devices

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This research considers the fundamental frequency of cantilever beams. The study includes new insight on the free vibrations of a simple elastic beam, and an analysis of the steady vibration response of piezoelectric vibrating energy harvester (PVEH) cantilever unimorphs.

Vibrating cantilever beams are a fundamental building block in many sensor devices, such as atomic force microscopes, sensors of biological and chemical substances, gyroscopes and many more.

In this study we investigate the effects of beam width and Poisson ratio, on the fundamental frequency of a resonating cantilever beam. We show that the fundamental frequency increases with increasing beam width, and with an increase of the Poisson ratio. Our investigation suggests that this increase in fundamental frequency should be attributed to a decrease in effective inertia rather than an increase in stiffness.

Cantilever PVEH devices are becoming increasingly relevant as potential power sources for autonomous sensors. Many previous studies considered the optimal planform of a PVEH, that maximizes the harvested energy.

In the present work, we derive the optimal planforms of two different PVEH unimorph cantilever configurations: a PVEH with an edge block that is patterned in both device and handle layers; and a PVEH which includes an edge block that is patterned only in the device layer.

We show that when the inertia of the beam is negligible relative to that of the edge block, the optimal planform of the PVEH is trapezoidal. However, when the inertia of the beam is as dominant as the inertia of the edge block, the contours of the optimal planform of the PVEH are described by Bessel functions. In this work, for the first time ever, we derive explicit analytic expressions of the optimal planforms of PVEH devices. We demonstrate the predictive capabilities of our new models, confirming that they are useful as design tools for developers of PVEH devices.

Note: the seminar will be given in Hebrew

Seminars Coordinator: Assoc. Prof. Gal Shmuel.