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## Nanoelectromechanical resonators for logic operations

There has been remarkable interest in nanomechanical computing elements, which can potentially lead to a new era in computation due to their re-configurability, high integration density, and high switching speed. The last decade has witnessed increasing research interest in mechanical computing for scalable mechanical computing elements. This has been primarily driven by the need to overcome the higher leakage current and power dissipation of the transistor technology, which have become pronounced as the technology is reaching its physical limit. Downscaling MEMS devices into the nano regime offers exciting opportunities for realizing devices of ultralow power consumption, high sensitivity, and high integration density. The ongoing progress in nanofabrication technologies has enabled exploration of nanoelectromechanical systems (NEMS) for mechanical computing for memory and logic gate devices. In this work, we present an in-plane nanomechanical beam resonator, operated in its linear regime, capable of dynamically performing NOR, NOT, XNOR, XOR, and AND logic operations. The stiffness of the nano-beam and hence its resonance frequency is modulated electro- thermally with two DC voltage sources representing the logic inputs. We also present for the first time an in-depth investigation into the performance of such electromechanical resonators under the effect of frequency fluctuations with temperature variation. The performance of this re-configurable logic device is examined at elevated temperatures, ranging from 25°C to 85°C, demonstrating its resilience for most of the logic operations. The proposed device can potentially achieve switching rate in μ sec, switching energy in nJ, and an integration density up to 106 per cm$^2$. The practical realization of this re-configurable device paves the way for nano-elements-based mechanical computing.

### Biography

Mohammad I Younis received his PhD degree in Engineering Mechanics from Virginia Polytechnic Institute and State University in 2004. Since 2004, he has been serving as an Assistant and then as an Associate Professor of Mechanical Engineering at the State University of New York (SUNY), Binghamton, NY, USA. Currently, he is an Associate Professor of Mechanical Engineering at King Abdullah University of Science and Technology, Saudi Arabia, where he has served as a Director of the MEMS and NEMS Characterization and Motion Laboratory. He is a recipient of the SUNY Chancellor's Award for Excellence in Scholarship and Creative Activities in 2012, the National Science Foundation Faculty Early Career Development Award in 2009, and the Paul E Torgersen Graduate Research Excellence Award in 2002. He serves as an Associate Editor of *Nonlinear Dynamics*, the *Journal of Computational and Nonlinear Dynamics*, and the *Journal of Vibration and Control*.

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