



## **Periodic and Quasi-Periodic Responses in Self-Excited Piezoelectric Resonators**

G. S. Sharama<sup>1</sup>, R. Abdel-Rahman<sup>1</sup>, E. Charmey<sup>1</sup>, T. Poisson<sup>1</sup>, M. Abdelrahman<sup>1</sup>, Helene Debeda<sup>2</sup>, M. Yavuz<sup>3</sup>, E. Abdel-Rahman<sup>1</sup>

<sup>1</sup>*Department of Systems Design Engineering, University of Waterloo, Waterloo, ON, Canada*

<sup>2</sup>*CNRS, Bordeaux INP, IMS, UMR 5218, University of Bordeaux, Talence, Aquitaine, France*

<sup>3</sup>*Department of Mechanical and Mechatronics Engineering, University of Waterloo, Waterloo, ON, Canada*

### **Abstract:**

We report on the dynamics of in a simple self-excited piezoelectric actuator implemented on a breadboard. The system is comprised on an operational amplifier (op-amp) connected in a closed-loop configuration to a piezoelectric disk actuator. Unsurprisingly, the circuit voltage and current undergo a complex evolution from periodic to quasiperiodic orbits as the op-amp's feedback mechanism is varied. Surprisingly, this has significant and interesting applications.