# Vibration control of a cantilever beam coupled to a non-ideal power source by coil impedance matching

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**Abstract**. In this paper, a numerical and experimental study of the Sommerfeld effect is shown using a cantilever beam with a DC motor positioned at the free end, and an attached permanent magnet that moves inside the core of a fixed coil. The movement of the beam and attached permanent magnet relative to the coil core induces an electromotive force if the circuit is closed. The control of the electric current allows the variation of the electromechanical interaction force on the beam. This is achieved by changing the impedance that closes the circuit with the coil. It is concluded that the short circuit practically reduces the oscillatory capture of the Sommerfeld effect.

## Introduction

There is an increasing interest in the research of systems excited by non-ideal power sources (NIS) due to the various physical phenomena that affect their efficiency in engineering applications. The focus of such research is usually on the dynamics of a flexible structure with a limited power source. A common phenomenon is known as the Sommerfeld effect, which affects unbalanced rotating machines supported by flexible mounts, widely studied by Kononenko [1] and Balthazar *et al*. [2]. In such a case, power is converted into mechanical vibration instead of increasing the motor speed. One of the problems often faced by designers is how to drive a system through resonance and avoid the Sommerfeld effect. In this paper, an analytical, numerical, and experimental study to control this phenomenon was performed on a system consisting of a cantilever beam with a DC motor positioned at the free end, similar to Gonçalves *et al*. [3]. The motor has an unbalanced mass, making it a source of non-ideal excitation. At the bottom of the beam free end there is a permanent magnet that moves inside the core of a fixed coil that is used to control the system vibration, as shown in Figure 1.

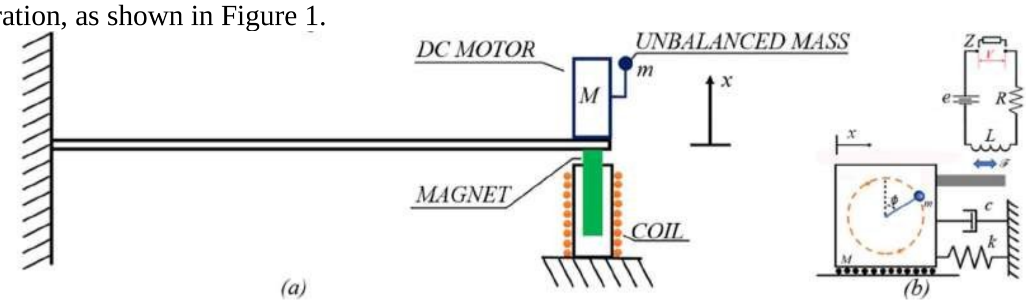


Figure 1: System consisting of a cantilever beam, unbalanced DC motor, permanent magnet and fixed coil (a), and the representative model of the system (b).

## Results and discussion

The vibration of the beam causes the permanent magnet to move inside the coil core, inducing an electromotive force. The control of the electrical current allows the variation of the electromechanical interaction force to reduce the amplitude of vibrations of the beam. This is done by changing the impedance that closes the circuit with the coil, see Wojna *et al*. [4] . This impedance was varied in its extremes, short circuit, and open circuit, and it is shown that the short circuit greatly reduces the oscillatory capture of the Sommerfeld effect. The analytical, numerical, and experimental results show that variations of the resistance in the magnetic circuit has a decisive impact on the Sommerfeld effect. The amplitude of the acceleration is reduced with the reduction of the total resistance of the circuit. The characteristic jump, or discontinuity, resulting form resonance capture can be eliminated with appropriate impedance matching.

## References

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