- General informations

- Supervisor's names : Berger Sébastien and Bergeot Baptiste

- Status : Professor

- Supervisor's emails : sebastien.berger@insa-cvl.fr baptiste.bergot@insa-cvl.fr

- Laboratory : Laboratoire de Mécanique Gabriel Lamé

- Institution : INSA Centre Val de Loire http://www.insa-centrevaldeloire.fr/fr/

- Scientific competence of the supervisor

Mechanical systems, non-linear dynamics, stability analysis, friction-induced vibrations, Non-linear Energy Sink, uncertainties, Chaos polynomial method, robust conception

- Two major publications in the field proposed for the PhD

- Bergeot, B., Berger, S., & Bellizzi, . Mode coupling instability mitigation in friction systems by means of nonlinear energy sinks : numerical highlighting and local stability analysis. Journal of Vibration and Control, 1 may 2017

- Minh-Hoang Trinh, Sébastien Berger, Evelyne Aubry, Stability analysis of a clutch system with multi-element polynomial chaos, Mechanics & Industry, vol. 17, number 2, 205, 2016, http://dx.doi.org/10.1051/meca/2015061

- Title of the research work
  Passive vibration mitigation of multi-instabilities in industrial mechanical systems using nonlinear energy sinks

- Subject

- General context

With the tightening of the economic context, industrialists need to design mechanical systems increasingly efficient and respecting a high level of safety. In dynamic system, safety is related to the control of the uncertainties in the design cycle on one hand, and the ability of the system not to vibrate on the other.

To take account of uncertainties, probabilistic methods have been already developped in the laboratory with success.

To ensure the system not to vibrate , vibration control is a relevant solution. Today, two major types of technologies are used predominantly in the industry: the passive dissipation control and the active control, each method having its technical advantages and disadvantages. Recent studies on the use of nonlinear absorbers (a passive dissipation control also known as Nonlinear Energy Sinks, NES) have

shown their capabilities to mitigate vibrations while exploiting the advantages of the existing technologies cited previously. Most of the theoretical and numerical studies on this topic are dedicated to academic systems with a small number of degrees of freedom. Moreover, some experimental studies exist but industrial applications remain marginal. The design of such devices for industrial applications is therefore a major research issue.

- Issues

The capacity of NES to mitigate dynamical instabilities which cause unwanted vibrations has been already studied in the past in many areas of mechanical engineering such as vibration induced by friction. However, these works have two limitations: (i) they consider only phenomenological models with few degrees of freedom and (ii) they do not take into account the possibility of multi-instabilities which has been observed in Finite Element model (FEM) of friction systems.

- Objective of the PhD work

The research work is oriented towards friction systems applications. The main goal is to study and analyze the capacity of the NES to mitigate multi-instabilities in industrial systems. For that, the successful candidate will focus on two issues. The first is an investigation of the possible response regimes of a multi-unstable mechanical system coupled to several NES using numerical simulations; firstly, with a simple phenomenological model and then with FE models. The uncertainties parameters will be taken account with the methods developped in the laboratory. The second is the understanding of the mitigation phenomena using mathematical analyses of the phenomenological model coupled to several NES. The expected benefits of the PhD work are a FEM demonstrator and theoretical design criteria of the NES.

- Validation of the research work

This work has an interest in both fundamental and applied sciences. From a scientific point of view, it will investigate the targeted energy transfer between a multi-unstable system and a strongly nonlinear component. From a technology standpoint, it will offer to industrialists a passive control tool with theoretical design criteria.

- Keywords
  non linear energy sinks, vibrations, mechanical systems, dynamical systems, asymptotic methods, finite element method, uncertainty, system safety, robust design

- Expected collaborations
  Laboratoire de Tribologie et Dynamique des systèmes - Ecole Centrale Lyon
  Industrial partners

- Background required from the applicant
  The candidate should hold an university degree (Master of Science or equivalent) in mechanics including necessarily a research internship. He/she should be comfortable with mathematical developments and program writing (programming languages as Matlab, Mathematica or Python)