

## *Editorial*

# **Nonlinear Vibrations, Stability Analysis, and Control**

**Carlo Cattani,<sup>1</sup> Alexander Seyranian,<sup>2</sup> and Irina Trendafilova<sup>3</sup>**

<sup>1</sup> *Department of Pharmaceutical Sciences (diFarma), University of Salerno, Via Ponte Don Melillo, 84084 Fisciano, Italy*

<sup>2</sup> *Institute of Mechanics, Moscow State Lomonosov University, 119192 Moscow, Russia*

<sup>3</sup> *Department of Mechanical Engineering, University of Strathclyde, Glasgow, UK*

Correspondence should be addressed to Carlo Cattani, ccattani@unisa.it

Received 24 October 2010; Accepted 24 October 2010

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Important advances in mathematics, physics, biology, economics, and engineering science have shown the importance of the analysis of nonlinear vibrations, instabilities, and strongly coupled dynamical behavior.

New investigation tools enable us to better understand the dynamic behavior of more complex structures. However, the increasing interest in mechanical structures with extreme performances has propelled the scientific community toward the search for solutions of complex problems and systems exhibiting strong nonlinearities. As a consequence, there is an increasing demand for both high-performance, nonlinear structural components as well as advanced multidisciplinary and multiscale mathematical models and methods.

It should be kept in mind that linearity is one of the properties of dynamic systems which is very rarely fulfilled. Nonetheless, if the system under consideration is not strongly nonlinear, then the methods of spectral and correlation analysis can be applied and will lead to sensible results describing a linear approximation of the system at hand. But there are cases of strongly nonlinear systems for which the output signal might not be even proportional to the input. This is a very important problem if one is trying to determine, for example, extreme values of the system response like in cases of catastrophic structural failure prediction. In such cases of strong nonlinear behavior, the system nonlinearities should be taken into account. When dealing with phenomena involving large amplitude and/or high frequency vibrations or a great number of coupled oscillators, the classical methods of linear dynamics have to be replaced by new specific mathematical tools.

In this special issue, the current state of nonlinear structural dynamic models in vibration analysis, stability analysis, and control has been reviewed. Known methods for analysis of nonlinear and oscillating systems at a macroscopic scale have been explored in

some new problems, and some new techniques have been applied to complex structures as well.

There are thirty five papers, collected in this special issue on Nonlinear vibrations, stability analysis, and control, that are shedding light on a wide range of topics; however, they do not cover all rich contents of these important fields.

Mathematical models and methods for nonlinear and strongly coupled (correlated) oscillating systems and for distributed-parameter structures have been investigated and improved in the following main topics:

- (i) vibration analysis of distributed-parameter and multibody systems, parametric models,
- (ii) global methods, wavelet methods, and fractal analysis for spatially and temporally coupled oscillators,
- (iii) nonlinear time series methods for dynamic systems,
- (iv) control of nonlinear vibrations and bifurcations, control of chaos in vibrating systems is as well as transient chaos chaotic oscillators and bifurcations.
- (v) Micro- and nano-vibrating structural systems.

This special issue deals with interesting and modern problems in vibrations, stability, and control. Some of these papers investigate theoretical problems while others are devoted to more practical applications. Some papers deal with structural engineering methods and applications such as stochastic finite elements, laminated composite plates, Jeffcott rotor, Euler-Bernoulli and magnetic beams, vehicle-pipes-soil vibration, gear transmission, and compressor vibrations. Others are devoted to biomechanical applications: cardiovascular system, ossicular chain, and human standing model, while some papers discuss oscillations, stability, and control problems in challenging topics, such as quantum interaction, financial systems, and energy production.

The collection of papers in this special issue covers a very wide range of applications ranging from purely mathematical tools for engineering problems to applications of nonlinear dynamics tools for human and economic problems. Some of the papers are dedicated to mathematical methods based on nonlinear dynamics tools, for example, wavelets for solving different mathematical and engineering problems. Others concentrate on specific nonlinear systems with well-expressed nonlinear behavior and offer methods for their analysis. The special issue contains studies on different engineering applications of nonlinear dynamic systems for the analysis of the behavior of essential structural components like beams, plates, and pipes. Some papers offer nonlinear-dynamics-based analysis of important machinery components and applications, for example, rotors, gear transmissions, vehicle vibrations, power transmission lines, hydraulic systems, compressors, gas stations, controllers. Medical, human, climate, and financial applications of nonlinear dynamics tools are considered also.

In all these papers, the authors efforts succeeded in showing the importance of nonlinear vibrations, stability, and control topics in opening new frontiers for challenging future researches.

*Carlo Cattani  
Alexander Seyranian  
Irina Trendafilova*