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EDITORIAL

Preface

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The following papers were selected by the Guest Editors, Professors Yuri Mikhlin (National Technical University "Kharkov Polytechnic Institute," Ukraine), Francesco Pellicano (Modena University, Italy), and Oleg Gendelman (Technion, Israel) from papers presented at the Fifth International Conference "NONLINEAR DYNAMICS -2016," which was held at National Technical University "Kharkov Polytechnic Institute" in Kharkov, Ukraine, on September 27–30, 2016. The conference was dedicated to the 90th anniversary of outstanding Ukrainian scientist Academician V.L. Rvachev. A total of more than 80 scientists, including many young researchers, from Australia, Brazil, Canada, Germany, Israel, Italy, Latvia, Poland, Russia, Serbia, Sweden, UK, Ukraine, and USA attended the Conference. The Conference demonstrated the wealth of interest in nonlinear dynamics across the world.

The Special Issue contains 13 peer-reviewed papers. The papers cover various aspects of nonlinear dynamics, including modeling, development of new methods of investigation, theoretical/numerical investigations, applied problems, experimental discoveries. Topics of the papers are related to actual and complex problems of the shell and plate nonlinear dynamics, dynamics of systems with limited power supply, active vibration control, dynamics of carbon nanotubes, rotating systems, development of methods of the forced transient and parametric vibrations.

The content of the 13 papers are briefly summarized in the following.

1. Marco Amabili. Nonlinear Damping in Large-Amplitude Vibrations: Modelling and Experiments.

This paper focuses on modeling and analysis of the correct nonlinear damping; namely, geometrically nonlinear viscoelasticity is applied to the fractional linear solid model. Identification of the nonlinear damping parameters is made from the experimental data. The results are compared with experimental forced vibration responses measured for large-amplitude vibrations of a rectangular plate, a circular cylindrical panel, and a clamped rod made of zirconium alloy.

2. José M. Balthazar, Angelo M. Tusset, Reyolando M.L.R.F. Brasil, Jorge L.P. Felix, Rodrigo T. Rocha, Frederic C. Janzen, Airton Nabarrete, Clivaldo Oliveira. An overview on the appearance of the Sommerfeld effect and saturation phenomenon in non-ideal vibrating systems (NIS) in macro and mems scales.

A main objective of this review is to describe a modern state of the problem of nonlinear behavior of systems with limited power supply (non-ideal systems).

The Special Issue "Multiscale Mechanics and Physics: New Approaches and Phenomena" is dedicated to Professor Ali Hasan Nayfeh.

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Such systems are characterized by interaction between the source of energy and elastic sub-system which is under action of the source. This paper represents some topics of nonlinear and chaotic phenomena found in modern and emergent engineering practice, in special to the field of electrical, mechanical, acoustic, and complex-electromechanical systems. In all of them, the Sommerfeld effect is presented and analyzed by different analytical, numerical, and experimental investigation .

3. Marco Barbieri, Sinniah Ilanko, Francesco Pellicano. Active vibration control of seismic excitation.

In the present paper, a time varying controllable spring is considered as a vibration isolator for mechanical systems. Numerical investigations show that the controller is capable of filtering seismic excitation close to the natural frequency of the controlled system and reducing the total seismic energy transfer.

4. Ivan D. Breslavsky, Marco Amabili. Nonlinear vibrations of a circular cylindrical shell with multiple internal resonances under multi-harmonic excitation.

In this paper, the nonlinear response of a water-filled, thin circular cylindrical shell, simply supported at the edges, to multi-harmonic excitation is studied. The complex nonlinear dynamics is analyzed around the resonance of the excitation on the fundamental mode. At this frequency, both vibration modes with two and three circumferential waves are driven to resonance and each one is in a one-to-one internal resonance with its companion mode. The nonlinear dynamics is explored by using bifurcation diagrams and time responses.

5. Shiyang Chen, Bogdan Epureanu. Forecasting bifurcations of multi-degree-of-freedom nonlinear systems with parametric resonance.

This paper presents a model-less method to predict bifurcations of slightly damped multi-degree-of-freedom nonlinear systems with parametric resonance using transient recovery data in the pre-bifurcation regime. This method is based on the observation that the envelope amplitude of a decaying response in the pre-bifurcation regime recovers more slowly to the equilibrium as the system becomes closer to the bifurcation. Data obtained from both simulations and experiments are used to forecast the location of the bifurcation point and the bifurcation diagram.

6. Oleg V. Gendelman. Escape of a harmonically forced particle from an infinite-range potential well: a transient resonance.

In this paper, a transient process of escape of a classical particle from a one-dimensional potential well is considered. The problem is reformulated in terms of action-angle variables. Then, the problem is analyzed in terms of averaged transient dynamics on primary 1:1 resonance manifold. The sharp minimum of the minimal forcing amplitude in the frequency-amplitude domain is related to formation of heteroclinic connection between the saddle points on the resonance manifold.

7. Fotios Georgiades. Nonlinear Dynamics of a Spinning Shaft with Non-Constant Rotating Speed.

In this paper, modeling of the spinning shaft with non-constant rotating speed and then discretization by using modes associated with the corresponding linear system have been done. In the discrete system which arises after truncation to the first mode, the method of multiple scales is applied. The four originally coupled equations of the first approximation are coupled in pairs. The first pair describes the rigid body motions coupled with torsion, and the second one describes two lateral bending motions. Nonlinear normal modes of the system which is written up to second order timescale are obtained analytically and compared with direct numerical simulation.

8. Ivana Kovacic, Stefano Lenci. Externally excited purely nonlinear oscillators: insights into their response at different excitation frequencies.

This paper is concerned with forced damped and essentially nonlinear oscillators. At the first stage, their dynamics is analyzed numerically for the response determined in the vicinity of a backbone curve with the aim of detecting coexisting responses that are not found previously analytically. Then, it is illustrated that the response at a low-valued excitation frequency has a form of bursting oscillations, consisting of fast oscillations around a slow flow. Finally, approximate analytical solutions are presented for the slow and fast flow for a general class of purely nonlinear oscillators.

9. Lidiya Kurpa, Galina Timchenko, Andrey Osetrov, Tetyana Shmatko. Nonlinear vibration analysis of laminated shallow shells with clamped cutouts by the R-functions method.

In this article, an effective numerical–analytical method to research geometrically nonlinear free vibrations of laminated shallow shells with complex planform is developed. The proposed method is based on joint use of the R-functions theory, variational methods, the Bubnov–Galerkin procedure, and the Runge–

Kutta method. Influence of the system parameters and boundary conditions to backbone curves is studied.

10. Nikolay V. Perepelkin. Non-iterative Rauscher method for 1-DOF System: A new approach to studying non-autonomous system via equivalent autonomous one.

This paper presents a new non-iterative variant of the Rauscher method with no iterative approaches, which is used for the analysis of forced harmonic oscillations in a nonlinear single-DOF system. Periodic orbits on phase plane are obtained as a set of points satisfying vanishing of a function which can be built a priori by studying three types of equivalent autonomous dynamical systems corresponding to the initial non-autonomous one. The equivalent systems can be investigated also semi-analytically by the harmonic balance method.

11. Valeria Settimi, Eduardo Saetta, Giuseppe Rega. Local and global nonlinear dynamics of thermomechanically coupled composite plates in passive thermal regime.

Unified 2D continuum formulation of the dynamic problem for a von Karman shear indeformable symmetric cross-ply laminated plate in a thermomechanical environment is presented, along with the ensuing reduction procedure ending up to a three-mode discretized model with unknown transverse displacement and membrane/bending temperatures. Systematic numerical analyses in the case of thermal dynamics passively entrained by the solely active mechanical excitations allow to unveil the main features of the nonlinear response. Local and global dynamics of a single-layer orthotropic plate are investigated. Influence of the thermomechanical coupling to the nonlinear response is discussed.

12. Tetyana Shmatko, Atul Bhaskar. R-functions theory applied to investigation of nonlinear free vibrations of functionally graded shallow shells.

Nonlinear free vibrations of functionally graded shallow shells with complex planform in the framework of the first-order shear deformation shallow shell theory are analyzed in the paper using the R-functions and the variational Rayleigh–Ritz methods. Effects of transverse shear strains and rotary inertia are taken into account. The properties of functionally graded materials are assumed to be varying continuously through the thickness. Frequencies are presented for three types of shallow shells with positive, zero, and negative curvature. Effect of volume fraction exponent, geometry of a shape, and boundary conditions on the frequencies is brought out.

13. Valeri V. Smirnov, Leonid I. Manevitch. Semi-inverse method in nonlinear mechanics: application to couple shell- and beam-type oscillations of single-walled carbon nanotubes.

In this paper, the resonant interaction of the nonlinear normal modes which belong to different vibration branches of the carbon nanotubes is studied by the semi-inverse asymptotic method under condition of the 1:1 resonance of the beam-like and circumferential flexure modes. Non-stationary solutions of obtained equations correspond to the slow change of the energy distribution. A description of the considered resonance process is achieved in terms of new variables, which are linear combinations of the shell- and beam-like normal modes. Not only nonlinear normal modes are analyzed but also limiting phase trajectories describing the strongly non-stationary dynamics.

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