Preface to Second Edition

The intention of the Second Edition of this book is to extend the previously published one with the new results of investigation in the matter. Besides, the application of the suggested methodologies on some practical problems is presented.

In this book, a new chapter is added in which vibrations of the axially purely nonlinear rod are considered. A new method, based on Hamiltonian approach, for the determination of free vibrations of the oscillator is considered. Now, there is a variety of procedures for solving free strong nonlinear oscillators in this book. Which of the method would be applied depends on the user.

In this book, the comparison between two oscillators with symmetric and asymmetric nonlinearity is given. The type of the model depends on the real physical problem which has to be described. Vibrations in an optomechanical system are discussed.

Forced vibration of the oscillator excited with the excitation force in the form of the Ateb periodic function is also discussed. A procedure for excitation design and derivation of amplitude–frequency equation is considered.

For the oscillator with two degrees of freedom, the generalization of the solving procedure is done. Based on the obtained results, vibrations of the vocal cord are analysed. To make the text more understandable, two new appendices are added: one, the Fourier series of the ca Ateb function, and the second, inverse incomplete Beta function.

I thank the publisher for the offer to publish the recent version of this book.

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Preface to First Edition

This book is the result of my long-time investigations and interest in the field of nonlinear vibration. The intention of this text is to give the approximate analytical solution procedures for strong nonlinear oscillators and to explain some of the phenomena which occur in such systems. This book considers the free and forced vibrations, takes the positive and negative damping of Van der Pol type, analyses the criteria for deterministic chaos and investigates the parametrically excited vibration in one-degree-of-freedom oscillators. Special attention is given to vibration properties of the two-mass system with two-degrees-of-freedom. The oscillation of the rotor, modelled as an one mass system with two-degrees-of-freedom, is also discussed. The ideal and non-ideal nonlinear mechanical systems are also treated where the jump phenomena, the Sommerfeld effect and the control of the system are included. The basic part for all considerations is a pure nonlinear oscillator whose order of nonlinearity is any positive rational number (integer or non-integer). This type of nonlinearity is the generalization for the previously discussed linear or pure cubic oscillators and oscillators with small nonlinearity. All the suggested solution procedures are based on the exact or approximate solution of the strong nonlinear differential equation which is the mathematical model of the corresponding oscillator.

I hope that this book will be suitable to be a textbook for the students in nonlinear vibrations, but also for those who are researching the nonlinear phenomena in oscillatory systems in mechanics, mechanical devices, electromechanical systems, electric circuits, physics, chemistry, etc.

This book has an intention to give some practical information for engineers and technicians dealing with the problem of vibration and its elimination. The results of investigation show that independently on the amplitude and frequency of excitation force by proper treatment of the strong nonlinear system, the vibration level may be kept at a small level. Namely, not only in mechanical systems like cutting machines with periodical motion of the cutting tools, presses, supports for machines, seats in vehicles, etc., but also in electronics (electromechanical devices such as micro-actuators and micro oscillators), the requirement of small oscillations but without introducing dampers, which cause energy dissipation and decreasing of the efficiency of machines, can be achieved by proper use of the nonlinear properties of the system.

The results published in this book are applicable for the improvement in designing, for example, of music instruments and their parts such as the hammers in a piano. At the other side, the investigation is also of potential interest for modelling human voice production in cases where the vocal cords and voice producing fold are damaged.

Finally, I have to thank Prof. Anatoly Andreevich Martynyuk, member of the Ukrainian Academy of Sciences, for his invitation to write and publish this book.

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