Summary

This habilitation thesis briefly presents the achievements of the authors in the scientific research developed after defending his PhD thesis within "Politehnica" University of Timisoara. These results are presented in 25 journal papers published in prestigious journals indexed by Science Citation Index, having significant impact factors, a monograph published by Springer Verlag – Berlin and other conference papers presented at national and international conferences as well as other journal papers. All these achievements have a good international visibility since one can identify more than 500 citations on ISI-Web of Science and more than 900 citations on Goole Scholar. All these conferred to the author a Hirsch index H=11 on ISI-Thomson Reuters and H=14 on Google Scholar.

The thesis is structured on 6 Chapters; the first 5 Chapters present the achievements of the authors in the last years and the last Chapter presents some evolution and development plans.

The main research direction on which this thesis is built-up is based on the study of nonlinear vibration using original analytical methods, which have been published in the literature by the author and his collaborators in the last decade.

After a brief introductory Chapter, the next 4 Chapters are intended to present the 4 original analytical methods proposed by the author in the literature: the Optimal Homotopy Asymptotic Method (OHAM), the Optimal Variational Iteration Method (OVIM), the Optimal Homotopy Perturbation Method (OHPM) and the Optimal Iteration Perturbation Method (OIPM).

All these original methods published in the literature by the author of the thesis and his collaborator Vasile Marinca after a close and fruitful collaboration, have a common idea, allowing obtaining solutions to problems related to nonlinear dynamical systems from mechanical engineering in an optimal approach. The analytical solutions depend on several initially unknown parameters, called "convergence-control parameters" whose optimal values are determined through a rigorous algorithm intended to minimize the residual obtained after replacing the analytical solution in the initial equation, so that the solutions converge to the exact ones with a remarkable rapidity. The key of the problem which ensure the success of these methods consist in the determination of the optimal values of convergence-control parameters, which task can be accomplished in various ways, using some approaches such as the least square method, the collocation method, the Galerkin method, and so on, which are implemented using a computer and specific programs.

Chapter 2 of the thesis presents the results obtained using OHAM, which are published in a series of papers which up to now received 303 citations identified by ISI – Thomson Reuters and 585 citations identified by Google Scholar. It was remarked that this method was adopted by other researchers worldwide, including in developing some PhD thesis. In this Chapter there are approached some important problems from the field of nonlinear vibration, such as vibration of a beam with intermediate mass and rotary inertia, nonlinear vibration of some dynamical systems specific to electrical machines systems, in this Chapter besides conservative systems being approached also nonconservative systems, where damping is present.

Chapter 3 presents the results obtained using another original method, namely OVIM (Optimal Variational Iteration Method), which is proposed as an improvement to the method known in the literature as Variational Iteration Method (VIM), which does not provide facilities to control the convergence of the solutions, except performing more iteration. A significant improvement consists just in providing a facility to ensure a convergence control based on minimizing the residual error using the least square method.

Chapter 4 presents another original method proposed for the first time in the literature in 2010 under the name Optimal Homotopy Perturbation Method (OHPM). This method is proposed as an

improvement to another homotopy approach known in the literature as Homotopy Perturbation Method (HPM), which did not provide facilities to control the convergence of solutions. The proposed improvement proposes a convenient way to control the convergence of solutions, this facility being remarked and acknowledged in the literature by some researchers.

Chapter 5 present some iterative approaches proposed in the literature by the author, among them being another optimal approach based on the same concept of minimization of residual error in the frame of an iteration-perturbation scheme applicable in the study of nonlinear vibration.

Analytical developments presented within these Chapters for solution of different nonlinear and strongly nonlinear problems are always accompanied by numerical simulations intended to validate the obtained analytical results.

Finally, the last Chapter of the thesis is intended to identify some opportunities concerning possible development of researches and a continuation of increasing the performances of the proposed methods so that these methods would became mature ones, applicable with less computational efforts and largely accessible for anyone. There is identified significant opportunities to obtain new results by enlarging the research team which will involve future PhD students which will be enrolled.