Singularly Perturbed Problems in Mechanics (Fundamental Theoretical and Applied Aspects)

Lyudmila K.Kuzmina
KNRTU - KAI
RUSSIA
Lyudmila.Kuzmina@kpfu.ru

ABSTRACT

It is important study, that is concerned with the development of the concepts and methods of classical stability theory in reference to the problems of singularly perturbed class systems , generated by Mechanics problems . The various aspects of complex systems dynamics are considered. Methods of the modelling and analysis on the generalized methodology base, coupling the stability theory ideas and asymptotic theory manners, are elaborated. Non-traditional, extended approach, formed on A.M.Lyapunov's methods, N.G.Chetayev's stability postulate , the singularity postulate and the statements of parametric stability (P.A.Kuzmin),the stability on variables part(V.V. Rumyantsev) and quasi-stability (K.P.Persidskiy) is worked out. It gives universal tool that makes it possible to come near to the solving of fundamental problems in general modelling theory. The effective algorithm of engineering level is obtained, which is perspective for multidisciplinary systems. Besides all investigated objects are interpreted from unified positions as singular ones; effectual non-traditional technology of modelling, that uses *principally non-linear approach*, is established; the simple schemes of *decomposition of original systems (models) and of dynamic properties* are worked out; the generalization of the reduction principle, well-known in stability theory, is got for general qualitative analysis. This manner is permitting to construct the hierarchical sequence of simplified systems (and models) as comparison ones; to determine the conditions of the qualitative equivalence between original and shortened systems; to find the areas of their acceptability.

In the applications to Mechanics the elaborated methods are very effective, those are enabling to construct the acceptable shortened models(as *s-approximations*) by strict mathematical way; to substantiate strongly their correctness in dynamics, including Lyapunov's critical cases; to consider specific cases, inherent for mechanical systems; to evaluate the corresponding errors in such transition-simplifying.

The elaborated methods are illustrated on examples from Mechanics. In framework of this approach it is considered actual problems for fast gyros theory, electromechanical systems, robotic systems; mechanical systems with the friction, non-holonomic systems; Newton's model of point mass dynamics…

New elegant outcomes are obtained, that are interesting both for theory and for applications, both in general theory of singularly perturbed systems and in applied engineering problems. Also this approach is very perspective from gnosiological view point, for general knowledge theory, with revealing interesting new models.

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