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Stability theory methods in problems of mathematical modelling complex mechanical systems

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Actual problems of dynamics and modelling complex dynamic systems of the singularly perturbed class are discussed in this research. Many applied questions of Mechanics, mechanical engineering are generating such problems. From mathematical point the object of the study in work is connected with systems for that mathematical models are presented by differential or algebraic- differential equations, with small parameter in different degrees under derivatives. Such mathematical models are describing the many dynamic processes of concrete physic-technical nature. Among them:
problems of modelling and analysis in theory of mechanical systems with big friction, in non--holonomic systems theory, in gyroscopic systems theory, in theory of the stabilizations and orientation systems, robotic systems,…
Herewith small (big) parameters, corresponding to real physical parameters of the system, are revealed in procedure of models idealization for investigated object. The main purpose: the determination of the conditions, under which the solving problems of the qualitative analysis and synthesis can be reduced to study of the shortened models of the more low order. With development of the approach, founded on stability theory methods of A.M.Lyapunov, on N.G.Chetayev ideas, on statements of P.A.Kuzmin, V.V.Rumyantsev, the examined qualitative problems are interpreted as stability problems under parametric non-regular perturbations. Moreover for many real engineering applications it leads to the singularly perturbed subsystems near boundary of the stability area. With division variables and motions in system on components of different groups and classes (critical and the basic; slow and fast), with system state space expansion by introducing of additional variables (as which it is taken the system parameters) ,the conditions are defined, under which the solving of the dynamics qualitative problems (in the first : a stability problems; the problems of *e*, *h*-estimations) can be reduced to study of the constructed subsystems. Also the problem of proximity for solutions of original and shortened systems is discussed for infinite time interval. The correctness (in accepted here sense) conditions of constructed shortened models is formulated, with expansion of the traditional statements of classical stability theory, with considering of non-regular parametric perturbations. Besides the solving original problem is obtained by analytical or numerically-analytical methods.
The elaborated methods are very effective for examples from Mechanics. In framework of this approach it is considered actual problems of mechanical systems theory with the friction, Newton's model of mass point dynamics, non-holonomic systems theory, gyroscopic systems theory, electromechanical systems, robotic systems, …
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 reference to systems dynamics with friction this developed approach allows to reveal interesting new models.

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