S U M M A R I E S

Bereslavsky E. N., Aleksandrova L. A., Pesterev E. V. **Mathematical modeling of some filtration currents in underground hydromechanics.**

Within the framework of two-dimensional stationary filtering in uniform isotropic soil of incondensable liquid some filtration currents under hydrotechnical construction with areas of constant velocity of flow and under the groove of Zhukovsky through an irrigated soil stratum with underlying strongly penetrating pressure horizon are investigated under Darsi law. The solution of corresponding polyvalent mixed boundary value problems of analytical function theory is realized with the help of the conformal mapping method of special form areas. The results of numerical calculations are presented and the detailed hydrodynamic analysis of the influence of determining physical model parameters on the picture of currents is given.

Key words: filtering, groundwater, dam, groove, velocity hodograph, conformal mappings.

Bure V. M., Kumacheva S. Sh. **A game theoretical model of tax auditing with using a statistical information about taxpayers.**

The model of tax audits based on the hierarchical game whose players are tax authorities and taxpayers is considered. The tax authority interacts with each taxpayer by the scheme "principal-to-agent". The players are supposed to be risk neutral. Different cases of penalties are considered. For each case the players' profit functions and their optimal strategies are found. Special attention is paid to the aspect of making a decision about taxpayer audit. The given problem solution is considered with the usage of conjugate family property of distributions.

Key words: tax auditing, taxes, penalties, hierarchical game, optimal strategies, conjugate families of distributions.

Kuznetsova O. **Sixth and seventh Lyapunov quantities for Lienard system.**

The Lyapunov quantities are calculated when studying an important in engineering mechanics problem on the behavior of a dynamical system with parameter values close to the stability domain boundary. Note also that the method of Lyapunov quantities computation can be applied to small limit cycles investigation. a few methods and their numerical implementations are known at present for finding Lyapunov quantities and deriving their symbolic expressions dependent on the coefficients of expansion of the right-hand sides of the system equations. These methods differ by the algorithm complexity and compactness of the resulting symbolic expressions. Investigation of systems of a special type, called Lienard systems, is a very important problem. The symbolic expressions for the first seven Lyapunov quantities for the Lienard system were obtained with the help of modern symbolic computation software and using two different methods (Poincare method and the method of solution approximation in the time domain and in Euclidean coordinates). Expressions of the first five Lyapunov quantities were computed earlier. the expressions of 6-th and 7-th Lyapunov quantities are given in the paper.

Key words: Lyapunov quantities, limit cycles, dynamical system, stability domain, symbolic computation, Lienard system.

Matrosov A. V. **Computational instability of an algorithm of a method of initial functions.**

A method of initial functions is an analytical method for solving boundary problems of linear elasticity theory. Its usage in two dimensional problems for rectangular areas allows to satisfy boundary conditions only on two opposite sides while on two others boundary conditions are prescribed by types of functions used for specifying initial functions. This is the main weakness of this method. Another one is a computational instability of an algorithm of the method at high harmonics when using trigonometric functions in presenting the initial functions. So when the boundary conditions require a large number of members in trigonometric series to meet specified accuracy this does not allow the computation using traditional programming systems (C, FORTRAN, Java). But with analytical calculation systems like Maple, Mathematica etc. which allow to perform calculations with an arbitrary mantissa a realization of the algorithm of the method of initial functions is free from specified shortcoming. The possibility of these systems has allowed us to investigate and find the reason of the computational instability and perform numerical experiments to determine maximum harmonics when the calculations are still stable for rectangular areas with different dimensions.

Key words: method of initial functions, biharmonic problem, boundary problem, numerical-analytical algorithm, computational stability.

Miroshin R. N. **The definition of a generalized polynom by its attractor.**

We deal with one-dimensional dynamical system of the iterated generalized polynom type. The problem of the definition of this polynom is determinated by means of its known attractor of finite period. We decided to look into problem of both one and two period in detail. The results of investigation are illustrative with five examples.

Key words: nonlinear dynamical system, the attractor of finite period, cycle, generalized polynom, Chebyshev system of function.

Mishchenko A. V. **Modeling of conscious attention in processes of image cognition in human brain, based on adaptive-resonance neural networks.**

The paper describes architecture and functionality of cognitive artificial neural network, able to analyze and classify binary images by assigning a neuron for each created class. Analysis

of classified images is performed by their introspective comparison, which creates (trains) synapses connecting neurons-the-23s with neurons-the-whole. These connections induce attention-driven cognition by tuning similarity threshold according to learned structure. Thus, the ANN realizes the simple model of acquiring of abstract knowledge, becoming aware of this abstract knowledge as a result of introspection and, finally, cognition of reality in terms of these acquired abstract notions.

Key words: artificial neural networks, adaptive resonance theory, modeling of attention, modeling of consciousness, image processing.

Nikushchenko D. V., Nadymov E. N., Shushkov R. A. **An algorithm for numerical simulation of underwater vehicles with prominent parts, rudders and stabilizers.**

Main approaches of determining hydrodynamic characteristics of an underwater vehicle with prominent parts, rudders and stabilizers are presented. The "SubObject" software presented allows to simulate the flow around such systems on the base of a panel method. The results of numerical simulation of an underwater vehicle with wing systems are given.

Key words: liquid, underwater vehicle, wing systems, rheology, model, flow.

Fadeev S. S. **Conditions for limit boundedness of solutions of nonlinear mechanical systems in case of gyroscopic force domination.**

The study of mechanical system motion quite often turns to the study of systems of nonlinear ordinary differential equations. It's not rare when such systems are high-dimensional or contain huge amount of parameters that makes the analysis of the system rather difficult. In that case the most acceptable approach is a so called method of decomposition. It implies that the initial system has to be splitted into some more simple ones, each of them is separately investigated and then all the results are adapted to the initial complex system. In the paper the object of research is a class of essentially nonlinear systems in case of gyroscopic force domination. Application of both methods of decomposition and Lyapunov's second method allows us to find sufficient conditions of limit boundedness for solutions of such kind of systems.The problem of limit boundedness domain determination and estimation of the time needed to approach that domain was also solved.

Key words: nonlinear systems, limit boundedness, decomposition, gyroscopic forces.

Kulik B. A., Kurbanov V. G., Fridman A. Ya. **Theory of relations as instrument of semantic analysis of data and knowledge.**

One of the semantics objects is developing semantic analysis language. Predicate calculus language is often used as this kind of language. Its principal advantage is in its wide range of analytical potential. However, it is not always possible to utilize this language for analysing particular applications; therefore we need to implement some subsets of this language. Furthermore, usage of predicate calculus language provokes certain difficulties when analysing modifiable reasoning. These complications are likely to have led to the situation when non-classical logic, whose interpretation either doesn't exist or doesn't correspond to the tasks of semantic analysis of data and knowledge and is used as an instrument for hypothesis and abductive conclusion analysis. The concept of 'relationship' is frequently used in the basis of many methods and theories of semantic analysis of data. However, present theoretic approaches are just limited to a fairly developed language of theory of binary relations which are used in semantic analysis (semantic nets, ontologies, etc), and a language of relational algebra whose analytic capacity is rather restricted from the point of logical analysis. At the same time, man objects of semantic analysis by their structure do not meet narrow limits of binary relations. Moreover, in the field of mathematical logic the discrepancy of reasoning (theory) system is defined only for the case when some consequence and its negation are simultaneously concluded from some premises. However, both in everyday and non-formalized scientific reasoning one of the indisputable criteria of system inconsistency is derivation of contrary consequences (e. g. it is concluded from premises, that "all a own B"

and simultaneously "all A do not own B"). Formally both statements are not negative relative to each other. to eliminate this and other discrepancies between formal logic and natural reasoning it is suggested to introduce the concept of 'collision' to the system of logical analysis. Collisions become apparent generally in modifiable reasoning in introducing new knowledge (hypothesis) as violations of some formally expressed rules or restrictions, which help regulate integrity or semantic content of the system. The method of modifiable reasoning analysis — with provision for collisions — on structures of N-tuple algebra is brought forward in the paper. This method allows to use universal techniques of modifiable reasoning analysis in semantic studies without violation of classical logic rules.

Key words: theory of relations, predicate calculus, semantic analysis, collision, abductive conclusion, modifiable reasoning.

Lepikhin T. A. **Methods of increasing performance of digital systems with linear feedback.**

The necessity in on-board implementation of automatic control systems involves the use of modern computer technology. Since such systems are mainly based on digital devices they require involvement of relevant formal methods and computer tools. In some cases direct application of the known optimization methods face significant challenges determined by the peculiarities of the problems being solved. The focus in the paper is concentrated on the choice of linear state or measurement feedback coefficients providing the speed increase of closed-loop system with regard to dynamic requirements demanding of it. Three new methods of improving performance based on the direct incorporation of requirements to modal properties of a closed system are suggested. The methods developed define simple computational algorithms of synthesis which can be used both in laboratory conditions and adaptive real-time adjustment to changing dynamic properties of the control object and the conditions of its functioning. The efficiency of the proposed approach is illustrated on a specific example of synthesis of the approximate optimal control law of the transport marine ship course.

Key words: marine ships, optimization, linear feedback, real time, digital devices.

Karelin V. V. **Penal functions in the problem of process supervision control.**

The problem of reducing a constrained mathematical programming problem to an unconstrained one has been given a great deal of attention. In most cases such a reduction is performed with the help of so-called penalty functions. At present the theory of penalization is well developed and widely used. The exact penalization approach is most interesting and elegant but it generally requires solving a nonsmooth problem even if the original one was smooth. However, recent developments in nondifferentiable optimization give some hope that these difficulties will be overcome. To be able to reduce a constrained optimization problem to an unconstrained one via exact penalization it is suitable to represent the constraining set in the form of equality where the function describing a set must satisfy some conditions on its directional derivatives (or, in general, on its generalized directional derivatives) . in the present paper we show how to describe the constraints – given in the form of differential equations – by a (nonsmooth) functional whose directional derivatives satisfy the required properties . The paper is devoted to the problem of supervision process optimization for dynamical systems at casual indignations. This problem is reduced to a nonsmooth unconstrained optimization problem. It makes it possible to construct a numerical algorithm for the unconstrained optimization problem just allowing one to solve the original parametric optimization problem. Then, by making use of necessary optimality conditions (for a nonsmooth problem) it is shown that the conditions we obtain are equivalent to the well-known ones.

Key words: observability, the differential equations, penal functions, not differentiated optimization, management.

Kvitko A. N., Nwokhiri A. **Solution of the problem of spatial movement control of an aircraft mass center.**

An algorithm for constructing the control functions for the changes in the angles of attack and roll in which an aircraft mass center moves from an initial state to the set final one is suggested. A constructive criterion guaranteeing the specified transition taking into account constraints on the control and phase coordinates is found. Numerical modelling of the set problem for an aircraft moving in a vertical plane with specific rigidly defined parameters is given.

Key words: control, phase coordinates, attack angle, bend angle.

Smirnov N. V., Shakhov Ya. A. **Multi program stabilization of the quasi-linear system.**

A problem of the multi program stabilization for the quasi-linear systems is considered. A sufficient condition for existing the control is proved. A method of practical realization of this control with a priori computing precision of motions is proposed.

Key words: quasi-linear system, multi program control, multi program stabilization.