ABSTRACT AND REFERENCES

MATHEMATICS AND CYBERNETICS – APPLIED ASPECTS

## SIMULATION OF VECTOR RANDOM SEQUENCES BASED ON POLYNOMIAL DEGREE CANONICAL DECOMPOSITION (p. 4-12)

**Vyacheslav Shebanin, Igor Atamanyuk, Yuriy Kondratenko**

We propose a mathematical model and the method for generating realizations of vector random sequencesbased on the apparatus for canonical expansions of V. S. Pugachev. The developed method, in contrast to those existing, makes it possible to takefull accountof nonlinear stochastic connections and does not set any substantial constraints on the properties of the examined random sequence (scalarity, Markovian behavior, monotony, stationarity, ergodicity, etc.).Taking into account the recurrent nature of determiningthe parameters of the method, its realization is rather simple and it isposssible to achieve arbitrary accuracy of representation of the examined sequence that depends only on the capacities of PC. The work also presents block diagrams of the algorithms, which reflect peculiarities of the functioning of the obtained method. Results of the numerical experiment confirm the increase in the accuracy of the developed method for generating realizations of random sequences by 2,0–8,5 %.

The proposed methodmay be used for solving a wide circle of applied problems, connected toexamining the objects with randomly changing conditions of functioning.

**Keywords**: vector random sequences, canonical decomposition, method for generating realizations.

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## MODELLING THE EXPERT'S PREFERENCES IN DECISION-MAKING UNDER COMPLETE UNCERTAINTY (p. 12-17)

**Dmytro Bugas**

The object of the research is the formalized problem of decision-making under conditions of complete uncertainty of the external environment, whereas the subject of the research is decision-making criteria. The aim is to ensure the effectiveness of managerial decisions by widening the spectrum of mathematical models of the criteria for their selection. The study considers classical and derivative criteria for decision-

making under conditions of complete uncertainty. We have suggested a three-parameter mathematical model of the Hurwitz criterion, which, in contrast to the classical model, makes analytical use of the number of conditions of the external environment (the dimension/scope of the problem) and considers the extent of its influence on the decision-maker's preferences in making decisions. The developed research instrument can be used in the procedures of a group or individual expert assessment of the efficiency of managerial decisions. The advantages of the proposed model include its ability to retain the form of the parameters' interrelation, regardless of the correction of the initial hypotheses. The maximum effect of its use can occur during a multiple group or individual expert assessment, when the calibration of subjective preferences of an expert is particularly important.

**Keywords**: decision-making criteria, Hurwitz alpha-test, uncertainty, expert assessment.

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## STATISTICAL VALIDITY AND DERIVATION OF BALANCE EQUATIONS FOR THE TWO-LEVEL MODEL OF A PRODUCTION LINE (p. 17-22)

**Oleg Pihnastyi**

A method of constructing a system of multi-moment balance equations, based on the statistical description of a production system is proposed. The need for research is determined by current trends in the development of production systems. The system of equations, which simulates the behavior of the production line for the transient conditions is obtained. It is shown that the resulting balance equations are not closed. The methods of closure of the self-linking chain of balance equations: the small-parameter method and the method of setting the equations of states for higher-order moments are considered. The known models using various methods of closure of the system of equations are analyzed. The model of the production line for the assembly-line production method is considered. The limitations and constraint equations, which enable the transition to single-moment PDE model of description of the assembly line and two-moment PDE model of the production line using the Burgers' equation are shown. The model of the production line for the company with the flow production method is considered. One-, two- and three-moment systems of equations for the two-level model of the production line are obtained. A general system of balance equations for the flow parameters of the production line is constructed.

**Keywords**: PDE model, production line, kinetic equation, production process, multi-moment equations, two-level description, object of labor, technological resources, phase space, assembly-line model.

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## METHOD OF SOLVING FUZZY PROBLEMS OF MATHEMATICAL PROGRAMMING (p. 23-28)

**Lev Raskin, Oksana Sira**

A brief analysis of traditional methods of solving fuzzy problems of mathematical programming was carried out. The shortcomings of the known approaches, limiting their application for the problems of real dimensionality, were revealed. The solution of the problem is achieved with the use of a two-stage procedure. At the first stage, a usual optimization problem is solved, which is caused by the original problem with the replacement of fuzzy parameters with their modal values. In this case, standard technologies of solving the problems of mathematical programming are used. At the second stage, a distinct solution, which satisfies two special requirements, is searched for. First, this solution must minimally deviate from the modal, obtained at the first stage. Second, membership function of fuzzy value of the optimized function, corresponding to the solution, must have a minimum level of uncertainty. In this connection, a complex criterion, which contains two appropriate components, is formed for solving the problem. A parameter of regularization, which assigns the value of the weight coefficient, determining the value of components, is introduced into the proposed complex criterion. This regulating multiplier provides acceptable level of the ratio between contradictory requirements, corresponding to the components of the criterion. The proposed approach for solving the problem of mathematical programming with not clearly defined parameters has the following benefits. Complex criterion has a distinct meaning and the corresponding computational procedure is simple. The implementation of its first stage is ensured by a traditional set of tools of determined optimization. The problem of the second stage when using standard membership functions, as a rule, comes down to the problem of quadratic programming. The account of theoretical material of the work is accompanied by examples.

**Keywords**: problems of mathematical programming, fuzzy parameters, method of solution, complex criterion, regularization.

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**USE OF COMPUTER PROCESSING BY THE METHOD OF MULTI-THRESHOLD CROSS SECTIONS FOR THE ANALYSIS OF OPTICAL IMAGES OF FRACTAL SURFACE MICROSTRUCTURE (p. 29-35)**

**Igor Kolupaev, Oleg Sobol', Alexander Murakhovski, Tatiana Kol'tsova, Mariya Kozlova, Valentin Sobol'**

Multi-threshold slices of an intensity of the optical images of the surface were used for a quantitative assessment of physical and chemical processes on the covering. Computer analysis was applied for testing the real relief by correlation of the image intensity with a geometrical profile representation (axis Z is accepted as optical microscopy intensity scale). The multithreshold method of image analysis proposed and applied in the present study is based on an assessment of the fractal dimension of relief elements rather than the entire surface "as a whole", which makes the processing procedure effective in the images of any origin (not only optical microscopy data, but also scanning electron microscopy).

It is shown that the replacement of full-profile analysis with the analysis of the series arrays of the sections along the axis of the intensity makes the determination of the fractal dimension of complex surface topography formed under non-equilibrium conditions quite simple.

The effect of the thickness and the stress-strain state of ion-plasma diboride's layers formed as the fractal dimension surface structure was considered. The use of colour optical image analysis techniques and assumption about the existence of the four components of the graphene layer on copper, opens the way to carry out morphological analysis of islands of each type and propose the model of stages of formation of the graphene coating.

**Keywords**: computer analysis, method of multithreshold sections, intensity scale, fractal dimension, ion-plasma coating, grapheme.

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**ANALYSIS OF BEHAVIOR OF SOLUTIONS' SUPPORT FOR NONLINEAR PARTIAL EQUATIONS (p. 35-40)**

**Kateryna Stiepanova**

An actual problem is the study of thermal processes in a fairly large range of temperature changes. This, in turn,

leads to the study of nonlinear heat equations. In addition, note that in the study of the heat distribution process in space (when we are dealing with a non-constant temperature), as is well known, there are heat flows which are directed from places with higher temperature to places with the lowest temperature. As a result, the equation contains absorption. An adequate mathematical model in this case is a semilinear second-order parabolic equation, which includes the absorption. For such equations, it is very difficult (often impossible) to write the solution explicitly. Therefore, the study of the properties of solutions is an important and urgent problem. The paper analyzes the behavior of the solutions' support of the Cauchy problem for the above-mentioned above partial differential equation. The result of the research is a theorem, which was proved in the work. It states that under certain conditions on the parameters of the problem, shrinking property of support holds.

**Keywords**: solution, Cauchy problem, partial differential equations, support.

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## RECURRENT APPROXIMATION AS THE TOOL FOR EXPANSION OF FUNCTIONS AND MODES OF OPERATION OF NEURAL NETWORK (p. 41-48)

**Alexander Trunov**

The paper considers the role of recurrent artificial neural network (RANN) for the solution of specific problems of coordination control, the relevance of which is predetermined by the development of modern automated systems. We synthesized the RANN information processing structure that is formed based on the indicators – vectors and recurrent approximation of continuous function. New modes of its work and expanded functionality were examined. It was demonstrated that it is capable to implement zero correction modes, calibration, preparing information on the error of approximation, to solve the problem of minimization and act as a module of decision making support system.

We proposed generalized algorithm for analytical determination of synaptic weights coefficients and evaluation of their error. It is shown that the application of the indicator vectors makes these algorithms practically independent of selecting initial approximation of synaptic weights coefficients, while the network acquires mechanism of readjustment during optimal control. For its implementation, depending on the changes that occur to the object, in accordance with the obtained analytical criteria of evaluation of error of synaptic weights coefficients, their readjustment is conducted. The synthesized structure is able to realize algorithms that provide a necessary set of operating modes and formation of productive or controlling rules based on the analysis of behavior of the set of the indicator vectors. Its structure forms the information support of the conditional part of the rules "condition-action" and implements effective part in the algorithms of coordination control. It also is capable to implement simple algorithms for finding roots and control that minimizes or maximizes continuous function or the Lagrange function under conditions of existence of restrictions of inequalities for a nonlinear object.

The application of the obtained results is also useful for solving various separate problems: formation of productive rules for solving the problems of finding simple root of monotonic function, finding a not simple root of monotonic function, finding a root of oscillating function, selecting controlling influence and the problem on the synthesis of controlling influence. Obtained results continue and complement practical implementation of the idea of recurrent approximation for solving the tasks of modeling and design.

**Keywords**: RANN, modes of operation, productive rules, analytical training of neuron, error evaluation, coordination control.

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