ABSTRACT&REFERENCES

MATHEMATICS AND CYBERNETICS - APPLIED ASPECTS

## ASSESSMENT OF THE CONVERGENCE OF SOLUTIONS OF INTEGRO-DIFFERENTIAL EQUATIONS OF HEAT CONDUCTION IN CONDITIONS OF THE SYSTEM RELAXATION (p. 4-9)

**Timur Bosenko**

Modeling of relaxation processes is possible in the presence of relaxation components of a system, leading to consideration of integro-differential equations (IDE) of heat conduction taking into account relaxation functions and definition of the estimates of the convergence of their solutions. In this paper, we build solutions in times of system relaxation by the method of successive approximations.

This method allows explicitly specify the time interval on which there is the solution, unlike the existing methods, involving the introduction of relative time. The function, which defines the scope of application of IDE of heat conduction only at intervals of system relaxation, is given. As appears from the definition of boundedness of input functions and their derivatives, the equation has bounded solutions at all critical points of relaxation. The conducted analysis determines the boundedness, uniformity and existence of solutions under the influence of relaxation, allowed to carry out the evaluation of the integral terms of the heat conduction equation.

In this paper, the boundaries of existence and uniformity of solutions of heat conduction problems for IDE taking into account the thermal memory are defined. Theorems on the existence of uniformity and convergence of solutions of the integro-differential equation on the interval $0<F_O\le F_{Or}$ and the boundedness of functions $|\Theta(X, F_O)|$, $|\partial_{Fo}\Theta\ (X, F_O)|$ at $F_O\to\infty$, which are responsible for thermophysical properties of material, are proved. This allows to perform calculations at times of relaxation of the system of locally-nonequilibrium state of material in problems of heat and mass transfer

**Keywords**: relaxation, integro-differential equation, thermal memory, convergence, localization time

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## USING OF THE COMPUTER ALGEBRA SYSTEMS IN THE ELEMENTARY NUMBER THEORY (p. 10-13)

**Leonid Bedratyuk, Anna Bedratyuk**

Recently we have seen the active penetration of computer algebra systems to the educational process because it allows to form an innovative learning technologies. Almost every branch of mathematics the Maple developed the separate specialized package commands. However, currently these technologies, despite its effectiveness and visibility, for various reasons, are still not common in the classroom. The purpose of this article is to review basic information about the capabilities of computer algebra to solve some common problems of the elementary number theory, and which can be used to solve educational problems. The paper describes the package description commands NumberTheory of the computer algebra system Maple. The methods of solving some common problems in the number theory in Maple. Using discussed the team package Maple a teacher can illustrate the problem solving in the classroom for the subject of the elementary number theory

**Keywords**: number theory, Maple, algorithms, divisibility, congruence, Legendre symbol, primitive roots

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## MATHEMATICAL MODELING OF POLLUTANTS MIGRATION IN SOILS (p. 14-16)

**Tatyana Bojko, Alla Abramova, Julia Zaporozhets**

The paper gives the analysis of mathematical tools in the sphere of hydro-ecological research in the study and prediction of the state of aquatic ecosystems. The specific of mathematical description of industrial effluents distribution was revealed to study the influence of anthropogenic impact on soils. It was found that the mathematical models of the influence of waste water on soil condition should be formed taking into account the type of waste waters, that is impurities containing in them and interacting with soil particles; soil properties and composition, that is type, structure, shape of pores and cracks in the soil, as well as the presence of water in its composition; interaction processes between them. The mathematical model of mass transfer of solutes in seepage flows of non-conservative pollutants was proposed, which describes the interaction between soils and waste waters. It was established that the difficulty occurs in solving mass transfer equations, which describe fluid motion in a porous media, and depends mainly on the structure and properties of soils, shape of pores and cracks that must be taken into account in the preparation of boundary conditions

**Keywords**: mathematical model, mass transfer, aquatic ecosystems, soils, industrial effluents

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## MULTIPROCESSOR TECHNOLOGIES OF MODELING MONTE-CARLO PROBLEMS (p. 17-20)

**Gennady Shvachych**

The process of mathematical modeling of applied Monte-Carlo problems based on the use of multiprocessor computation system found further development in the paper.

Operating experience of the first parallel systems has shown that their efficiency requires radical change of the structure of numerical methods. In this connection, the corresponding distributed algorithms were developed, the features of modeling applied problems based on multi-processor systems were identified and shown.

Application of the developed approach provides a new way to consider the idea of computation parallelization and the use of cluster computation technologies. A modified algorithm for parallel computation using the Monte-Carlo method is proposed in the paper.

Here, each computer has its own random number generator. In this case, the intermediate computations are carried out independently on different, individual cluster blades - “computers”, and the results are processed at any individual master-blade - “analyzer”.

This allows to get rid of the indispensable presence of router-communicator between the random number generator and “computer”. Obviously, this solution allows speeding up the computational process.

The computational schemes that enhance the productivity and performance are given. The effectiveness of the proposed approach is illustrated by a comparative analysis of solution of some class of problems

**Keywords:** cluster computing, parallel computing algorithms, Monte-Carlo method, local optimization

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## SEMIDEFINITE SYMPLEX-METHOD FOR SOLVING THE QUADRATIC OPTIMIZATION PROBLEMS (p. 21-24)

**Anatolii Kosolap**

We propose a new semidefinite simplex-method for solving the semidefinite optimization problems. In this paper, a general quadratic problem is transformed to a linear semidefinite one using a semidefinite relaxation. We look for a semidefinite matrix in the semidefinite optimization problem. Such matrix can be represented as a sum of the rank-one matrices. The proposed semidefinite simplex-method uses the semidefinite matrix in the form of a linear combination of matrices of the rank-one matrices. We find each such matrix solving the problem of minimizing the quadratic form.

If the minimum of the quadratic form is non-negative, the semi-definite optimization problem is solved. Otherwise, we continue to search the rank-one matrix, which will reduce the value of the objective function of the semidefinite optimization problem. In general, solution of the semidefinite optimization problem defines only the lower bound of the solution of the initial quadratic problem.

We use this solution as a starting point for the quadratic optimization problem. We solve this problem by a primal-dual interior-point method.

The numerical experiments showed that the found solution often coincides with the point of global minimum of the quadratic optimization problem

**Keywords**: quadratic functions, semidefinite relaxation, semidefinite optimization, semidefinite simplex method, interior-point method

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## ESTIMATION OF THE STABILITY FACTOR OF ALPHA-STABLE DISTRIBUTIONS USING FRACTIONAL MOMENTS METHOD (p. 25-30)

**Vadim Shergin**

The problem of estimating the stability factor of alpha-stable distributions was considered. Such distributions are widely used in models of stochastic processes, describing a wide class of processes and phenomena.

The analysis of existing methods of the estimation of parameters of stable distributions was carried out. It was noted that stable distributions do not have moments of the second and higher orders. This makes it impossible to use such classical statistical method for the estimation of parameters as the method of moments.

The use of the method of fractional moments for the estimation of parameters of stable distributions is proposed in the paper. The mathematical basis of the method of fractional moments is the theory of Mellin transforms.

The estimates of the required factor were obtained in the exact and approximate forms. The consistency and asymptotic unbiasedness of these estimates were proved, and their asymptotic variance was calculated.

The values of the moments, which minimize the asymptotic variance of estimates of the stability factor, were found. These values depend on the value of the estimated stability factor.

The numerical modeling, which confirmed the obtained results, was conducted

**Keywords**: stable distributions, estimation of stability factor, fractional moments, asymptotic variance of estimates

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## ADAPTIVE MODELING IN THE PROBLEM OF SEARCHING OPTIMAL CONTROL OVER THERMOTEMPORARY MELT TREATMENT IN ELECTRIC-ARC FURNACE (p. 31-37)

**Dmitry Demin**

The synthesis of optimal control over the process of electric-arc melting, based on the mathematical modeling of physicochemical processes, proceeding in the ''melt-slag-lining-furnace atmosphere'' system, is the task, the solution of which allows the full implementation of all necessary recovery and oxidizing processes in the melt, thus minimizing the losses of chemical elements in the alloy and increasing the alloy quality. The main problem of the solution of this task is obtaining the mathematical description of the processes of forming the chemical composition of melt under the change of external factors, influencing the system. These are such factors as the change of bath geometry and its temperature as a result of the removal of a certain portion of melt from the furnace in the moment of order generation by the foundry conveyor.

For the solution of this problem, the procedure of estimation of parameters of the kinetic equations, describing temporal variation of the content of chemical elements in the melt bath at the stage of thermo-temporary treatment of cast iron in the electric-arc furnace, was proposed in the paper. Such procedure is based on the realization of adaptive approach to the modeling, which lies in the realization of iterative procedure of estimation of kinetic equations coefficients.

he obtained result can be used for the solution of the problem of searching the time-optimal control, allowing the system to reach the specified final state, which is formed by such chemical composition of the alloy, which provides the solution of the problem of satisfying the melt quality by several output variables at once. It is shown, that the surface of the final state can be obtained by the solution of two problems: obtaining of adequate mathematical models of the ''structure-quality'' type and the further analysis of the response surface aimed at solving the problem of compromise optimization. As a result, the obtained solutions can be used for the setting up tasks to the system of electric melting control

**Keywords**: mathematical model, optimal control, adaptive approach, alloy, cast iron

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## CHOOSING MEDICATIONS FOR SUBCLINICAL CHRONIC HEART FAILURE OF ADOLESCENTS

(p. 38-41)

**Helena Vysotskaya, Larissa Rack, Olga Svatenko**


As a result of the fact that prescription of medications for children and adolescents with early stages of chronic heart failure is not provided by the treatment protocols, and the doctor has to act intuitively, the development of methods for decision-making support gains a special relevance. In this paper, the authors proposed method of optimal selection of medications at subclinical variants of chronic heart failure of adolescents, taking into account the features of multifunctional characteristics of heart on the basis of analytical networks.

The main stages of the method and the results of its introduction in the SI "Institute for Children and Adolescents Health Care of the NAMS of Ukraine" are described in the paper. Application of this method will allow reasonable choice of the best among the set of alternative variants, taking into account the indicators of the patient's condition, dependences between these indicators and medications, feedbacks between them in the network structure, and also will promote the prescription of effective therapeutic measures and prevention of progression of early stages of chronic heart failure of adolescents. The proposed method can be easily realized in the outpatient or inpatient conditions, and its use allows to achieve considerable technical result


**Keywords**: chronic heart failure, adolescents, treatment, method of analytical networks

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## BALANCE DYNAMIC MODEL OF THE CELL CYCLE

(p. 42-47)

**Nadezhda Gernet, Anatoliy Bozhkov**


The development of new mathematical and computer approaches and the needs of fundamental medicine and biology have raised a complicated issue of modelling a living cell. This may be solved today with achievements of theoretical and experimental methods. It is especially interesting to model a cell at different stages of its life cycle, including its division, differentiation and death. The paper considers mathematical modeling of cell cycle,

being a dynamic sequence of events from one cell division to another.

Based on the system analysis of the available data on the living cell development and functioning, it is suggested to consider the cell cycle as an integrated dynamic process of the interaction of intracellular matter flow, energy, and information directed on the reproduction of the new living cell.

The work analyses the specifics and essential preconditions of the cell cycle description using the balance dynamic model, which sets the balance of reproduction, distribution and consumption of matter, energy, and information inside the cell for each temporary subinterval of the cell cycle.

The regularities and peculiarities of the cell development dynamics and their influence on the processes of organism aging are considered on the basis of formal mathematical properties for built dynamic model and its simplified modifications. The questions of practical using the offered model are discussed

Keywords: living cell, mathematical modeling, balance model, cell cycle, the dynamics of the cell development

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## MODELING OF THE INFLUENCE OF MEASUREMENT ERRORS OF BASE TANGENTS OF TEETH ON THE INDICATORS OF SORTING

(p. 48-52)

**Vitaliy Derbaba**

For the choice of the measuring instruments with an acceptable measurement error, the technique, given in the national standard GOST 8.051-81 is used. However, this technique is applicable only to smooth junctions and does not take into account geometrical features of involute teeth of wheels. The objective of the paper is to determine the dependence of the sorting indicators of base tangents of involute teeth on the limiting random error of measurement.

The method of simulation statistical modeling, adapted in relation to the assigned task was applied. The modeling was carried out both for the case of zero error of measurement, and for the limiting value of the random error, which is taken as input data. It provides the calculation of the percent of incorrectly accepted and incorrectly rejected pairs of teeth. The statistical modeling was conducted on the basis of the random number generator, built in Microsoft EXCEL. The accepted assumptions concern the choice of the law of normal distribution for deviations of base tangent lengths from the nominal value and uniform law of distribution of random errors of measurement.

The dependences of the number of incorrectly accepted and incorrectly rejected pairs of teeth on limiting values of random error of measurement of base tangent length for degrees of accuracy of gearing 4, 5, 6, 7, 8 with various types of junction were obtained.

The procedure was used in the educational processes when training bachelors, specialists and masters in mechanical engineering.

The technique can be used in drawing up business-plans for decision-making during preparation of engineering production, which is characterized by the stochastic nature

**Keywords**: modeling, measurement, error, gears, base tangent length, sorting

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## MODELING DECISIONS WITH DEMPSTER-SHAFER BELIEF STRUCTURES (p. 53-58)

**Inna Skarga-Bandurova**

The paper presents the theoretical concepts and problems of decision making with Dempster-Shafer belief structures. We have presented a method of decision support based on belief structures which allows taking into consideration the subjective expert information that formalized in the form of family of estimations by forming the combination of hypotheses and using the ordered weighted average operators.

We have developed the decision making process allowing estimate the minimum and maximum objectives (risks and gains) and using different types of aggregation operators. Depending on the particular problem the different types of ordering operators has been used to ensure the variability of objectives: descending order for tasks where the purpose is to obtain the best results and the ascending order for the problems in which the lowest value is the best one

Finally, an illustrative example has been given to modeling different decisions

**Keywords**: Decision Making; Belief Structure; Dempster-Shafer Theory; Aggregation Operator

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