NAUKOVI VISTI NTUU "KPI". – 2013. – N 4. – 170 p.

Blashchak N.I., Syvak O.A.

Asymptotic Properties of Continuous Solutions of Linear Functional Difference Equations

P. 7–13.
Refs.: 7 titles.

The paper studies asymptotic properties of continuous solutions of linear functional difference equations of $x(t+1) = a\,x(t) + \sum_{j=1}^{\infty} b_j\, x(q_j\, t)$ type depending on assumptions concerning real constants a and $q_j,\ j = \overline{1,n}.$ Using the methods of the theory of differential and difference equations, new conditions for existence of continuous solutions of linear functional difference equations are established, we propose the method of constructing these solutions, study structure and behaviour of their set with $t \to +\infty$ and investigate their properties depending on conditions imposed to a , $q_j,\ j = \overline{1,n}.$ Specifically, under conditions $0 < a < 1,\ \ q > 1$ and $b = \sum_{j=1}^{\infty} |\, b_j\, | < \infty,\ \Delta = \frac{b}{a - a^q} < \frac{1}{2},$ we prove the existence of the family of continuous narrow solutions at $t \geq 0$ in the therem 1 depending on any continuous 1-periodic function. Its solutions are represented as series (2), where $x_i(t),\ \ i = 1, 2, ...,$ – some continuous functions, which are solutions of sequence equations $(4_i),\ \ i = 0, 1, 2, ...$ and satisfy the mark (5). Moreover, under the same conditions regarding real constants a and $q_j,\ j = \overline{1,n},$ we prove the theorem 2 for a nonlinear equation and the theorem 3 in case when $b_j,\ j = \overline{1,k}$ are functions of a real variable t.

Keywords: functional difference equation, continuous solution, asymptotic properties, conditions for the existence of continuous solutions.

Virchenko N.O., Izbash A.M.

Integral Equations with *r*-Hypergeometric Functions

P. 14–18.
Refs.: 5 titles.

Some new properties of the *r*-hypergeometric functions are investigated, in partial, the differential relations for the function ${}_rF^{\tau,\beta}(a,b;c;z)$ are proved, and also the relation of the Kummer type is proved. The Mellin' integral transform for the r -hypergeometric function ${}_rF^{\tau,\beta}(a,b;c;z)$ is received. The connection of the *r*-hypergeometric function ${}_rF^{\tau,\beta}(a,b;c;z)$ with the classic Gauss' hypergeometric function ${}_2F_1(a,b;c;z)$ is established. The formula of the representation of the *r*-hypergeometric function ${}_rF^{\tau,\beta}(a,b;c;z)$ in the kind of the Riemann–Liouville' fractional integral is proved. Applications of the *r*-hypergeometric functions in the theory of an integral equations are given. Volterra' integral equations of the first kind with *r*-hypergeometric function in the kernel are solved. The solutions of these integral equations in closed form by help of apparat of the theory of the fractional integro-differention are received.

Keywords: *r*-hypergeometric function; Kummer' relation; fractional integral; Volterra' integral equation of the first kind.

Virchenko N.O., Ovcharenko O.V.

r-Hypergeometric Function and its Application

P. 19–22.
Refs.: 9 titles.

In this paper with the help of the (τ,β)-generalized confluent hypergeometric function the r-hypergeometric function is considered. The aim of it is to study the main properties of the r-hypergeometric function, in particular, to study the relation of Erdelyi' types, the Mellin transform, the composite relation with integral operator of Erdelyi–Kober' type. In the study used common methods of the theory of special functions, the theory of integral transforms and operators of fractional integration. We also obtained the representation of the r-hypergeometric function by the fractional integral. Some applications of the r-hypergeometric functions to the solving of integral Volterra' equations in closed form are given. The results can be used for further development of the theory of special functions and their applications in different sciences.

Keywords: r-hypergeometric function; (τ,β)-generalized confluent hypergeometric function; Riemann–Liouvile fractional integral; integral equations with hypergeometric functions in the kernels.

Grechko A.L.
On Lyapunov and Ricatti Monotone Differential Matrix Equation
P. 23–26.
Refs.: 6 titles.

The purpose of the paper is to generalize the Polacik–Terescak theorem for a monotone differential matrix equation of Lyapunov and Ricatti. Our goal is to study the existence of the one-dimensional invariant manifold (corresponding to Lyapunov and Ricatti monotone differential matrix equation). Using the method introduced by Hilbert–Birkgoff in the projective contraction fixed point theorem, we determine conditions under which Lyapunov differential matrix equation has a one-dimensional invariant manifold in the cone of positive definite of quadratic form. The main assumption of this work is a strong monotonicity of a linear skew-product flow on trivial vector bundle. Specifically, we prove Lyapunov and Ricatti monotonicity of a differential matrix equation. Also, we establish the existence of the one-dimensional invariant manifold of Lyapunov equation. The proposed method of projective analogue fixed point principle applied to the differential Lyapunov matrix equation with a special low right-hand side allows to prove the existence of one-dimensional invariant manifold in the cone of positive quadratic forms.

Keywords: matrix differential Lyapunov equation, strong monotone linear extension.

Dyriv M.M., Kachanovsky N.A.
Stochastic Integrals with Respect to a Lévy Process and Stochastic Derivatives on Spaces of Regular Test and Generalized Functions
P. 27–30.
Refs.: 11 titles.

The extended (Skorohod) stochastic integral with respect to a Lévy process and the corresponding Hida stochastic derivative on the space of square integrable random variables (L^2) have many applications in the stochastic analysis, in particular, in the theory of stochastic differential and integral equations. But sometimes (for example, in order to consider so-called normally ordered stochastic equations) it is convenient to introduce and study these operators on certain spaces of test and generalized functions or on spaces of some riggings of (L^2). In particular, in this case there is a possibility to define the above mentioned operators as continuous ones, to study its interconnection with the so-called Wick calculus etc. In this paper, using the theory of Hilbert equipments, we introduce and study the extended stochastic integrals with respect to a Lévy process and the Hida stochastic derivatives as linear continuous operators on spaces of a so-

called parameterized regular rigging of (L^2). This gives a possibility to extend an area of applications of these operators.

Keywords: Extended stochastic integral; stochastic derivative; Lévy process.

Denysuk V.P.

Method for Improving the Convergence of Fourier Series and Interpolating Polynomials Based on Systems of Orthogonal Functions

P. 31–37.

Fig. 4. Tabl. 2. Refs.: 5 titles.

The aim of this paper is to develop and study the method for improving the convergence of Fourier series based on orthogonal functions systems. This method application allows us obtaining uniformly convergent series for smooth functions. Another goal is to develop and study the method of improving the convergence of interpolating polynomials, based on systems of orthogonal functions, which in many cases allows us to reduce an interpolation error by such polynomials. In addition, we develop the method of phantom functions and phantom nodes, whose characteristic feature is an approximation of a given function on the part of the orthogonality interval. We examine the developed methods using the test example in cases of both Fourier series and, respectively, trigonometric interpolating polynomials. The research results demonstrate high efficiency of the proposed methods. Finally, we establish the following behavior – in some cases the phantom nodes method leads to abnormal decrease of interpolation errors because the proposed method of phantom nodes does not completely fit into the modern theory of approximations, it requires further theoretical investigations.

Keywords: orthogonal systems of functions, Fourier series, convergency improvement, interpolation.

Zhukovska O.A., Tytarenko A.O.

Study of Distributive Law in Classical Interval Arithmetic for the General Case

P. 38–44.

Fig. 1. Refs.: 6 titles.

The aim of the article is to study the law of distributivity in classical interval arithmetic. We conduct the research for interval in the center-radius form. A set of intervals is represented as a combination of three subsets defined by values relations of centers and the radii. We prove the lemma about conditions under which the sum of two intervals will belong to the same subset of added intervals. We generalize the distributive law in case of voluntary number of intervals. The theorem about necessary and sufficient conditions of generalizing the distributive law for intervals belonging to one subset. These results allow to conduct research to improve the algebraic structure of a set of intervals.

Keywords: intervals, distributive law, generalization of the distributive law.

Zhurakovskyi B.M., Ivanov A.V.

Periodogram Estimator Properties of the Parameters of the Modulate almost Periodic Signal

P. 45–54.

Refs.: 16 titles.

The problem of detection of hidden periodicities is considered in the paper. In the capacity of useful signal model the modulated almost periodic signal is taken observed on the background of random noise being the local functional of Gaussian strongly dependent stationary process. For estimation of unknown amplitude and angular frequency of modulated signal periodogram estimators are chosen. Sufficient conditions on consistency and asymptotic normality of the estimators are obtained. The exact form of limiting normal distribution is found. To obtain the main result there were used limit theorems of random processes, weak convergence of a family of measures to the

spectral measure of a regression function, etc. The novelty, compared with the known results in the theory of periodogram estimator in observation models on weakly dependent noise, is assuming that the random noise is a local functional of Gaussian strongly dependent stationary process.

Keywords: periodogram estimator, almost periodic function, asymptotic normality, strong dependence, hidden periodicities, nonlinear regression.

Ivanov A.V., Prihodko V.V.

The Limit Theorems for Extreme Residuals in Linear Regression Model with Gaussian Stationary Noise

P. 55–62.

Refs.: 12 titles.

We consider linear regression model with continuous time and strongly dependent stationary Gaussian random noise. The behavior of normalized in some way extreme residuals, that are the maximum differences, or their absolute values, between the observations and the values of the regression function where instead of unknown parameter the least squares estimator is substituted. For linear regression model the conditions of weak convergence of normalized extreme residuals to double exponent curve are obtained which follows from the assumption of normality of random noise. In addition instead of unknown variance and the 2-nd spectral moment of Gaussian stationary noise the consistent estimators of indicated parameters are substituted in normalizing function. The variance estimator of noise generalizes the residual sum of squares of classical mathematical statistic and the 2-nd spectral moment estimator generalize Lindgren estimator. In the paper mathematical machinery of statistics of random processes and limit theorems for extremes of Gaussian stationary noise is used. New results obtained provide an opportunity to offer some non-traditional statistical tests for adequacy of the regression model.

Keywords: linear regression model, maximal residuals, weak convergence, Gaussian stationary noise, variance and the second spectral moment estimators, estimator consistency.

Klesov O.I., Tymoshenko O.A.

PRV Conditions of Unbounded of Solution of Stochastic Differential Equation

P. 63–66.

Refs.: 11 titles.

We consider the behavior of solutions of stochastic differential equation $d\xi(t) = a(t,\xi(t))dt + \sigma(t,\xi(t))dw(t),\ \ t \geq 0;\ \ \xi(0) \equiv \xi_0$, where w is a standart Wiener process; ξ_0 is a nonrandom positive constant; ξ is a solution of equation, a and σ are continuous functions. The aim of this work is to find conditions on functions a and σ, under which solution ξ tends to infinity. The solutions unboundedness of stochastic differential equations is one of the important research topics of the asymptotic behavior of stochastic differential equations solutions. I.I. Gihman and A.V. Skorohod obtained general results for solutions unboundedness for an autonomous stochastic differential equation. In this paper, we provide some sufficient conditions for the stochastic differential equation with a time-dependent coefficient under which solution tends to infinity for $t \to \infty$. We do the research based on the PRV-theory (the theory of pseudo-regularly varying functions) developed in a series of works by V.V. Buldigina, O.I. Klesov and J.G. Shteinebach.

Keywords: stochastic differential equation, unbounded of solution, regularly varying functions.

Kovalenko S.S., Kopas I.M., Stogniy V.I.

Preliminary Group Classification of a Class of Generalized Linear Kolmogorov Equations

P. 67–72.

Tabl. 1. Refs.: 13 titles.

The group-theoretic method is a modern research method for studying both linear and nonlinear partial differential equations. By using this method, we construct exact partial classical solutions of equations allowing for non-trivial symmetry groups. In this paper, a class of (2+1)-dimensional generalized linear Kolmogorov equations is considered. Our aim is to investigate symmetry properties of equations from the class and to use them to construct invariant fundamental solutions. By using the Akhatov–Gazizov–Ibragimov algorithm, the preliminary group classification of the class under study is carried out. For the equations with non-trivial symmetry properties, maximal invariance algebras re found. By using the Aksenov algorithm, we calculate the invariance algebra of fundamental solutions of the linear Kolmogorov equations. We use the algebra operators obtained to construct invariant fundamental solutions of the equation. We demonstrate that the fundamental solution obtained by A.N. Kolmogorov is an invariant fundamental solution of the linear Kolmogorov equation.
Keywords: group classification, linear Kolmogorov equation, algebra of invariance, equivalence transformations, invariant solution, fundamental solution.

Kozak V.I.

Inverse Spectral Problem for a Block Matrix of Jacobi Type Corresponds to the Real Two Dimensional Moment Problem

P. 73–76.

Refs.: 7 titles.

The purpose of this paper is to find matrices that correspond to some finite measure with compact support on the real plane, in other words, to solve the inverse spectral problem for the present two-dimensional moment problem (on the real plane). The paper defines the Jacobi matrix corresponding to the real problem of two-dimensional points and system of orthonormal polynomials relative to a certain extent with compact support on the real plane obtained by Schmidt orthogonalization in a certain order of two-index set of functions (indices belonging to a set of natural numbers including zero) of defined properties. Also, we obtain a pair of matrices with block tridiagonal structure acting in the space such as the algebraic commuting self-adjoint limited operators and define some of their properties. Previous research elucidates this issue only partially compared with the information presented in this paper.
Keywords: inverse spectral problem, block Jacobi-type matrix, real two-dimensional moment problem.

Ovcharenko O.V.

Application of the Theory of Fractional Calculus to Integral Operators with Generalized Hypergeometric Functions

P. 77–82.

Refs.: 12 titles.

The aim of paper is to study the properties of the integral operators with generalized hypergeometric functions in the kernels, in particular, to study the conditions of existence and their boundedness, the study of compositional relations with fractional integrals. In the study of common methods used by the theory of special functions, the theory of integral transforms and operators of fractional integro-differentiation. We introduce integral operators with (τ,β)-generalized hypergeometric functions in the kernels. For these operators the functional relationship and the conditions of existence and boundedness in Lebesgue space are obtained. Also obtained compositional relations for new introduced integral operators with left-sided fractional Riemann–Liouville integral. Applied apparatus of the theory of fractional calculus to generalized hypergeometric functions, namely: obtained functional relations that showing action of left-sided Riemann–Liouville fractional integral and derivative on a (τ,β)-generalized (according to Wright) hypergeometric Gauss function and (τ,β)-generalized confluent hypergeometric function. The results can be used for further development of the theory of special functions such of their widespread use.

Keywords: (τ,β)-generalized hypergeometric function; confluent hypergeometric function; derivative and fractional integral of Riemann–Liouville; integral operators with hypergeometric functions in the kernels.

Sanzharevsky I.Yu.

Variation Approach to the Dirichlet Problem with the Laplace Operator by Measure on Hilbert Space

P. 83–87.
Refs.: 6 titles.

We study the Dirichlet problem for the elliptic equation in the Hilbert space region. We aim at formulating the Dirichlet problem for the considered equation and the problem in a "weak form" implying the search of "weak solutions". In addition, the main task is to formulate and prove both existence and uniqueness of theorems for weak forms of the problem. We formulate and prove theorems of existence and unity of the first boundary-value problem and specifically source version of the formulated problem in the joint domain of left and right parts of the source equation. Moreover, the weak form of the problem will be solved by using the variation approach. We use methods of functional analysis to solve the problem and, in particular, the Riesz theorem. Also, the theory of unbound linear operators is widely used. We formulate and prove the theorem about existence and uniqueness of solutions for the equation in both source and weak forms. We succeed in studying and solving the first boundary value problem for the considered equation with the infinite-dimensional Laplace operator version introduced earlier by Bogdansky Yu.V. This fact gives a reason count on success in study of the second and third boundary value problems for the considered equation in a region of a Hilbert space.

Keywords: Hilbert space, Borel measure, derivation of measures, elliptic equations, Laplace operator, trace operator, Dirichlet problem.

Serov M.I., Spichak S.V., Stogniy V.I., Rassokha I.V.

Group Classification of Kolmogorov Nonlinear Equations

P. 88–93.
Tabl. 1. Refs.: 16 titles.

We consider Kolmogorov nonlinear equations with an arbitrary function. The group-theoretical method is one of the methods for solving partial differential problem. Using this method, we integrate equations with a non-trivial symmetry group. Therefore, group classification is high priority. Specifically, we conduct the group classification of Kolmogorov nonlinear equations. Using obtained continuous equivalence transformations, we present nonequivalent subclasses of these equations. We calculate maximum invariance algebras for all these subclasses. By employing the obtained subalgebras of invariance algebras for some nonlinear equations, symmetry is reduced to equations with a smaller number of independent variables. The reduced equations are integrated and exact solutions of the corresponding nonlinear equations are obtained.

Keywords: group classification, nonlinear equation of Kolmogorov type, invariance algebra, equivalence transformations, symmetry reduction, invariant solution.

Skuratovsky R.V.

Generators and Relations of Syllows *p*-Subgroups of Group S_n

P. 94–105.
Refs.: 8 titles.

In this article, we investigate generators and relations of syllows subgroups of some symmetric group. It will enable studying syllows subgroups of other groups since every finite subgroup is isomorphicaly embedded in the syllows subgroup of some symmetric group. We find a set of relations for a fixed system of generators and prove that this set of relations is minimal between sets of relations. Research methods are the method of Shreier's canonical words and rewriting process. In addition, we prove that such

subgroups have a finite presentation, notably it has finite number of generators and relation. We prove the existence of close connection of such subgroups with the iterated wreath product of cyclic subgroups with prime order – C_p. Therefore, it became the research subject. Also, we investigate the iterated wreath product, related to automaton group and transformations. Furthermore, the structure properties of symmetryc group S_{p^k} were previously studied, while we describe all other properties left. Specifically, we study commutants and corresponding verbal subgroups. We find the presentation for syllows p-subgroups of S_{p^k}, and S_n.

Keywords: syllows subgroup, wreath product, generetors and relations.

Gorobets O.Yu., Gorobets Yu.I., Rospotnyuk V. P.

The Electrolyte Movement at Etching and Deposition of Metals Under Inhomogeneous Constant Magnetic Field

P. 106–113.

Fig. 1. Refs.: 25 titles.

This paper considers the features of the electrolyte movement in the surface layer in the processes of etching and deposition of metals at a ferromagnetic electrode in the form of a ball, when it is magnetized in an external inhomogeneous magnetic field of the moderate intensity (~1 kOe). The choice of an electrode in the form of a ball makes it easy to distinguish the effects of magnetic fields from the effects of a different nature due to the equivalence of all points of its surface in the absence of magnetization in this model system. We show that nonuniform concentration distribution of paramagnetic or effectively paramagnetic cluster products of electrochemical reactions appears in an electrolyte under the influence of the inhomogeneous magnetic field of the magnetized ferromagnetic ball. For example, clusters can represent the micro- or nanobubbles, stabilized by paramagnetic or diamagnetic ions in electrolytes, and colloidal particles with their ionic environment. The concentration electromotive force, current density and the functional expression of the rotational speed of the electrolyte in a plane perpendicular to the direction of the external magnetic field are calculated in the surface layer of a magnetized steel ball, as well as the equation describing the interface between the areas in electrolyte with opposite rotation directions. The results of theoretical modeling can be used to create functional materials by methods of magnetoelectrolysis for modeling the impact of biogenic magnetic nanoparticles on the transport processes and biochemical reactions in the cells of living organisms.

Keywords: magnetohydrodynamic stirring, magnetoelectrolysis, effective paramagnetic susceptibility, gradient magnetic force, Lorentz force, micro- and nanobubbles.

Demchenko V.L., Shtompel V.I., Riabov S.V., Unrod V.I.

Effect of Magnetic Field on the Structure and Properties of Polymers and Their Composites

P. 114–120.

Refs.: 34 titles.

This paper studies the influence of magnetic field on the structure and properties of polymers and their composites. The analysis of research into the impact of magnetic fields on unfilled polymers and composites on their basis allows separate effects associated with the interaction of the polymer matrix with the magnetic field and the effects due to structuring ferromagnetic fillers. We establish that the structure of polymer composite materials changes under the impact of a magnetic field. It results in an anisotropic distribution of ferromagnetic fillers and changes the magnetic properties of polymers. We show that the magnetic field is an effective way to regulate the structure and properties of polymers and their composites as in the synthesis and in physical and chemical methods to modify them. The mechanism of the magnetic field and its effectiveness depends on material's magnetic properties.

Keywords: magnetic field, the magnetic field intensity, the polymer composite, structure, physical and mechanical properties.

Kosmachev O.A.

Features of Nematic Phase in Magnets with $S = 2$

P. 121–126.
Fig. 3. Refs.: 12 titles.

This paper investigates the nematic phase of isotropic non-Heisenberg magnet with spin magnetic ion 2. The spectrum behavior of elementary excitations in the vicinity of phase transition lines with other phases is implemented in this model. To solve the site problem, we use the method of diagonalization N-level system based on employing Hubbard algebra. The research found that the nematic phase in this phase is the geometric image of "corrugated" biaxial ellipsoid because of the additional parameter β. The spectra analysis on lines of the phase transition and additional analysis of the free energy with thermal fluctuations makes it possible to specify parameter β. We also show that the nematic phase is divided into "axial" and "planar" phases. The research conducted allows defining more precisely the phase diagram of the isotropic non-Heisenberg magnet with $S = 2$.

Keywords: non-Heisenberg magnetic, phase transition, Hubbard's operators, nematic phase, tetrahedron phase.

Lukianov P.V.

Compact Turbulent Vortex Generation: Approximate Model for Relatively Large Time Moments

P. 127–131.
Fig. 2. Refs.: 14 titles.

The aim of research is to develop the analytical model capable of approximate description of compact turbulent vortex generation by finite power circulation source for relatively large time moments. The method is based on turbulence gradient Boussinesk model according to which turbulent viscosity coefficient has a constant value. The research results show a slight difference between the analytical solution for the model problem with a constant turbulent viscosity coefficient with the one in the experimental turbulent Taylor–Cuette flow, characterized by the specified constant value, except for thin boundary layers. Specifically, we propose a simple analytical model for turbulent vortex generation. It is can be used for relatively large time moments when the flow is indeed quasi-steady. The obtained solution can't be used for turbulent diffusion problems when the circulation source stops its action. Then the main assumption for constant turbulent viscosity coefficient is not valid.

Keywords: compact vortex, generation, approximate model.

Lukianov Petro V.

Helicopter Rotor Blade-Vortex Interaction (BVI) Noise

P. 132–136.
Fig. 4. Refs.: 12 titles.

In this paper, a model of sound generation by blade–vortex interaction (BVI) is offered for helicopter rotor operating at subsonic regime ($M = 0,2$). We find the quantitative limits of its use. Based on three-dimensional non-stationary equation of small perturbations spreading, the problem of sound generation by parabolic blade and Taylor's vortex, situated at a certain distance from the blade, is solved. To solve this problem, we use the numerical-analytical method. The method allows calculating the near-field sound potential and its derivatives. The pressure coefficient analysis shows that the disposition of the blade-vortex interaction generates three surges like shock waves of A, B, C types (by Tijeman). However, interaction amplitudes are smaller than the ones for transonic regime. In addition, we reveal that BVI noise level is 10Db (with respect to $2 \cdot 10^{-5}$ Pa) more than the noise level in the similar problem without a vortex in the flux. The

numerical calculation shows that the limit distance, where the model is acceptable, is more than $1,5R_c$ (R_c is core radius). When the distance between vortex core and rotor blade increases, the BVI-noise level decreases.
Keyswords: BVI, sound generation.

Nelin E.A., Vodolazska M.V.
Quantum-Mechanical Structures with Delta-Functional Potential
P. 137–144.
Fig. 7. Refs.: 6 titles.

Based on the concept of quantum-mechanical impedance model, we develop the quantum-mechanical δ-inhomogeneities – δ-barrier and δ-well for nanoelectronics applications. Typical models for natural and artificial quantum-mechanical structures: single, double and triple δ-inhomogeneities; potential steps, wells and barriers with δ-inhomogeneities, lattice of δ-inhomogeneities are considered. We obtain analytical expressions for eigenvalues of structures. We give energy dependences of reflection and transmission coefficients for the typical quantum-mechanical structures with δ-functional potential. By comparing characteristics of inhomogeneities with the finite size, we analyze the δ-error. We consider crystal and crystal-like structure, defects in the crystal and surface levels. Impedance δ-model of the quantum-mechanical structures are distinguished by simplicity and clarity, wide possibilities of their use in the design of signal processing nanoelectronic devices, as well as teaching and learning tool.
Keywords: quantum-mechanical structures, delta-functional potential, quantum-mechanical impedance, the impedance model of δ-inhomogeneities, δ-function, δ-barrier, δ-well.

Olshanskii V.P., Olshanskii S.V.
Didion Inversion Solutions for the Problem of Point Ballistics
P. 145–147.
Fig. 1. Tabl. 2. Refs.: 10 titles.

The purpose of this study is to develop a convenient way to calculate distance (horizontal projection of the trajectory) flight of a particle in a gas medium with quadratic resistance movement to flatter trajectory. Didion solution converted to a form suitable for calculating the flight range of a particle in a gaseous environment is known in the theory of ballistics. The Lambert function table is proposed by calculating the flight range of a point on the flat trajectory. Using the built Didion inversion solutions and Lambert function tables greatly simplifies calculation of the flight range of a point on a flat trajectory. Didion inversion solutions are two-valued which is consistent with the presence in the trajectory of ascending and descending sections. Inversion can be used not only to calculate the flight distance of a point, but also to identify the quadratic resistance of the medium, in accordance with results of the trajectory measurements.
Keywords: inversion Didion solution, quadratic resistance, Lambert function.

Sidorenko S.I., Zamulko S.O.
Direct and Inverse Problems of Computer-Based Materials Design
P. 148–151.
Fig. 1. Refs.: 22 titles.

The paper analyzes tasks associated with new materials design recently applied in material science in light of the principle stating that new knowledge design should be based on the previously accumulated knowledge, as well as wide application of computer technologies and operating with material science databases. We show that the general problem of computer design of materials should be divided into 3 problems. The aim of the direct problem is to construct the interpolation polynomial based on available materials science discrete databases available. Accumulation, analysis and algorithms of materials science databases operation is a relatively independent task. After solving the direct problem (when interpolation polynomial is

constructed) an inverse problem may be solved using this polynomial: what chemical composition of material can provide obtaining predetermined properties (inverse problem of the first order). The inverse problem can be solved (what chemical composition will provide predetermined properties) through quantum-simulation modeling (from *ab initio*, for example). In this case, some restrictions are to be imposed on Schrödinger equation. When it is solved, the researcher obtains the chemical composition providing predetermined properties under conditions of imposed restrictions (inverse problem of the second order). Solving these problems for specific systems will facilitate creating new materials with predetermined properties.

Keywords: materials design, materials science databases, the direct problem, the inverse problem, the new materials with predefined properties.

Snarskii A.A., Bezsudnov I.V.
Critical Phenomena in Dynamical Visibility Graph
P. 152–156.
Fig. 3. Refs.: 16 titles.

We investigate the time series by mapping them to the complex network. We show that the technique of mapping proposed – the dynamic visibility graph has an intrinsic parameter behaving similarly to the order parameter in the theory of the second order phase transitions. The behavior of the relative number of clusters near the critical angle of view was thoroughly analyzed. Time series of different nature both artificial (having uniform random, Poisson and modification of Weierstrass distributions) and experimental (human heart beat RR intervals, data on solar flares and the time series of earthquakes) are numerically investigated. In all cases, the relative number of clusters depends on the proximity to the critical angle of view of power law. Thus, we show that there is an analogy between the behavior of the relative number of clusters and the order parameter in the second-order phase transition theory. Each time series is characterized by its own value of the critical index – an analog of the critical index in second-order phase transition theory.

Keywords: time series, visibility graphs, critical phenomena.