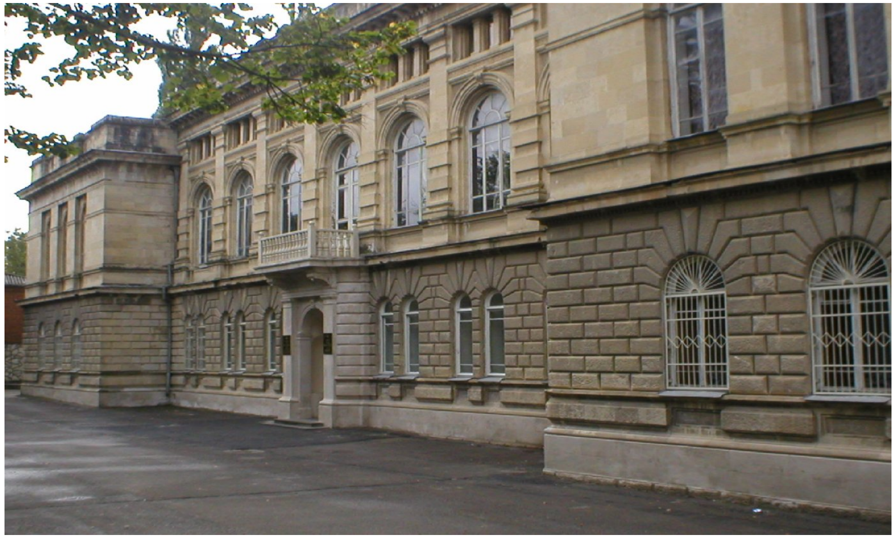

IV Annual Meeting of the Georgian Mechanical Union

BOOK OF ABSTRACTS
მოხსენებათა თეზისები

საქართველოს მექანიკოსთა კავშირის IV ყოველწლიური კონფერენცია

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Dedicated to 80th Anniversary of the Akaki Tsereteli State University

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ეძღვნება აკაკი წერეთლის სახელმწიფო უნივერსიტეტის დაარსებიდან 80 წლისთავს

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Mechanics of Deformable Solids

FLEXIBLE RODS WITH NONLINEAR PULSE PRESSURE FLUCTUATIONS DURING LOAD

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Stem systems which are interacting with air or fluid flow, are widely used in various fields of engineering. Significantly changing the form as a result of the impact stem the flow of form and forces acting on it are dependent on the form of the stem. There is little information about such a force, which creates certain difficulties for the calculation of such structures.

In many cases, in calculating the stem structures (ropes, power lines, etc.), the such characteristics, as hardness of Rolling and Bending can be ignored and it can be considered as a completely flexible stalk (filament).

The present work considers the non-linear pressure fluctuations hose when there is stationary fluid flowing stream. If the flow rate is zero, then, as a private event, we get the ropes, and power lines, traffic equations. Distributed by aerodynamic forces acting on the hose flow intensity may be present in the form of two summands:

$$\vec{q}_a = \vec{q}_{a,0} + \vec{q}_{a,d}\,.$$

where, $\vec{q}_{a,0}$ is the intensity of the aerodynamic force caused by the stationary flow and $q_{a,d}$ is a dynamic component flow. Differential equations are a pair of hose movement:

$$\vec{L}_1 = \frac{\partial^2 \vec{u}}{\partial \tau^2} + 2nw_0 \frac{\partial^2 \vec{u}}{\partial \varepsilon \partial \tau} + \alpha \frac{\partial \vec{u}}{\partial \tau} - \frac{\partial \vec{Q}_{1,d}}{\partial \varepsilon} + \vec{q}_{a,d} = 0\,, \qquad (1)$$

$$\dot{\vec{u}} - (\vec{e}_1 \vec{u}) - \frac{1}{Q_{10}}\left(\vec{Q}_{1,d}\vec{e}_1\right) - \frac{\vec{Q}_{1,d}}{Q_{10}} = 0\,. \qquad (2)$$

For solving these equations, first find the solutions for the case when the intensity of the internal flow rate and aerodynamic forces are zero. Solutions are obtained in the forms of vibration. We use the principle of possible displacements; look for a solution as a linear combination of the forms of vibration. Then go to the transformation of ordinary differential equations. Find solutions to them. These solutions allow us to define the geometric shape of the hose and tension. Their design skills are required for the calculations. From the analysis of solution we may conclude that the impulsive aerodynamic load increases significantly shrink tubing. These results will enable us to raise the construction of reliability.

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EFFECTIVE SOLUTION OF THE NEUMANN BVP OF THE LINEAR THEORY OF THERMOELASTICITY FOR A SPHERE AND FOR SPACE WITH SPHERICAL CAVITY

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The purpose of this paper is to be explicitly solved the Neumann type boundary value problem (BVP) of the linear equilibrium theory of thermoelasticity with microtemperatures for the sphere and for the whole space with a spherical cavity. The obtained solutions are represented as absolutely and uniformly convergent series.

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ON SOME NUMERICAL RESULTS IN THE ZERO APPROXIMATION OF THE HIERARCHICAL MODELS FOR LAMINATED PRISMATIC SHELLS

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The talk is devoted to simulations on computer of stress-strain state of laminated prismatic shells consisting of two elastic plies within the framework of the laminated prismatic shell model suggested in [1].

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AN ITERATION METHOD OF SOLUTION OF A NONLINEAR EQUATION OF A STATIC BEAM

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We consider the beam equation

$$u''''(x) - m\left(\int_0^l u'^2(x)dx\right)u''(x) = f(x), \quad 0 < x < l, \tag{1}$$

with the conditions

$$u(0) = u(l) = 0, \qquad u''(0) = u''(l) = 0. \tag{2}$$

Here $m(z) \ge \alpha > 0$, $0 \le z < \infty$, and $f(x)$, $0 < x < l$, are the given functions, $u(x)$, $0 \le x \le l$, is the function to be defined, while l and α are some known constants.

Equation (1) is the stationary problem associated with the equation, which was proposed by Woinowsky-Krieger (J. Appl. Mech., 17 (1950), 35-35) as a model of deflection of an extensible dynamic beam.

By means of Green's function, Problem (1), (2) reduce to nonlinear integral equation

$$u(x) = \int_0^l G(x,\xi) f(\xi)\, d\xi + \frac{1}{\tau}\varphi(x), \tag{3}$$

where

$$G(x,\xi)=\frac{1}{\tau\sqrt{\tau}\,\sinh(\sqrt{\tau}l)}\begin{cases}\sinh\left(\sqrt{\tau}(x-l)\right)\sinh\left(\sqrt{\tau}\xi\right), & 0<\xi<x<l,\\ \sinh\left(\sqrt{\tau}(\xi-l)\right)\sinh\left(\sqrt{\tau}x\right), & 0<x<\xi<l,\end{cases}$$

$$\tau=m\left(\int_0^l u'^2(x)\,dx\right),$$

$$\varphi(x)=\frac{1}{l}\left((l-x)\int_0^x \xi f(\xi)\,d\xi+x\int_x^l (l-\xi)f(\xi)\,d\xi\right).$$

Equation (3) is solved by an iteration method. The convergence of the method is proved.

ON A VIBRATION PROBLEM OF THE SINUSOIDAL CUSPED BEAMS IN THE (0,0) APPROXIMATION

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The aim of the present talk is to study well-possedness of initial-boundary value problems in case of (0,0) approximation of hierarchical models [1,2]. The setting of boundary conditions at the beam ends depends on the geometry of sharpening of beams' ends, while the setting of initial conditions is independent of them.

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HIERARCHICAL MODELS FOR LAMINATED PRISMATIC SHELLS

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The present paper is devoted to the results obtained within the framework of the SRNSF project "Modeling and calculating in practice widely-distributed structures with complicated geometry" (30/28). In the second part hierarchical models for laminated prismatic shells constructed by the author are presented. The first part contains a brief survey of results obtained by the other researchers involved in the project.

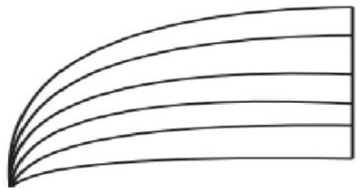

Figure 1 Cross-section of a cusped laminated prismatic shell

Using I. Vekua's dimension reduction method [1,2] hierarchical models for elastic laminated prismatic shells are constructed. For each leyer we construct hierarchical models assuming to be known stress vector components on the face surfaces of the laminated body (structure) under consideration, while the values of X_{ij} and u_i on the interfaces are calculated from their Fourier-Legendre expansions there. So, we get coupled governing systems for the whole structure in the projection of the structure e.g., for the zeroth approximation the governing system in the case of two plies has the form

$$\mu\left[\left(h_1 v^1_{\alpha 0,\beta}\right)_{,\beta}+\left(h_1 v^1_{\beta 0,\alpha}\right)_{,\beta}\right]+\lambda\left(h_1 v^1_{\beta 0,\beta}\right)_{,\alpha}+\frac{1}{2}\left\{\overset{(-)}{h}_{1,\beta}\left[\lambda v^1_{\gamma 0,\gamma}\delta_{\alpha\beta}+\mu\left(v^1_{\alpha 0,\beta}+v^1_{\beta 0,\alpha}\right)\right]-\mu\, v^1_{30,\alpha}\right\}$$

$$+\overset{(+)}{F}{}^1_\alpha=\rho\, h_1 \ddot{v}^1_{\alpha 0}(x_1,x_2,t),\quad \alpha=1,2;$$

$$\mu\left(h_1 v^1_{30,\beta}\right)_{,\beta}+\frac{1}{2}\left(\mu\overset{(-)}{h}_{1,\beta}\, v^1_{30,\beta}-\lambda v^1_{\beta 0,\beta}\right)+\overset{(+)}{F}{}^1_3=\rho\, h_1 \ddot{v}^1_{30}(x_1,x_2,t);$$

$$\mu\left[\left(h_2 v^2_{\alpha 0,\beta}\right)_{,\beta}+\left(h_2 v^2_{\beta 0,\alpha}\right)_{,\beta}\right]+\lambda\left(h_2 v^2_{\beta 0,\beta}\right)_{,\alpha}-G_\alpha+\overset{(-)}{F}{}^2_\alpha=\rho\, h_2 \ddot{v}^2_{\alpha 0}(x_1,x_2,t),$$

$$\mu\left(h_2 v_{30,\beta}^2\right)_{,\beta} - G_3 + \overset{(-)}{F}{}_3^2 = \rho\, h_2 \ddot{v}_{30}^2(x_1, x_2, t),$$

where

$$\overset{(\pm)}{F}{}_j^{\gamma}(x_1, x_2, t) := Q_{\overset{(\pm)}{v}_{\gamma} j} \sqrt{\left(\overset{(\pm)}{h}_{\gamma,1}\right)^2 + \left(\overset{(\pm)}{h}_{\gamma,2}\right)^2 + 1} + \Phi_{j0}^{\gamma},$$

$$G_j(x_1, x_2, t) := \frac{1}{2h_1}\left[X_{j\beta 0}^{1} \overset{(+)}{h}_{2,\beta} - X_{j30}^{1}\right], \quad j = 1,2,3, \quad \gamma = 1,2,$$

$$2h_{\gamma}(x_1, x_2) := \overset{(+)}{h}_{\gamma}(x_1, x_2) - \overset{(-)}{h}_{\gamma}(x_1, x_2), \ \gamma = 1,2,$$

$x_3 = \overset{(\pm)}{h}_{\gamma}$ are face surfaces of the plies, $\overset{(-)}{h}_1(x_1, x_2) = \overset{(+)}{h}_2(x_1, x_2)$ is the interface. For each ply the usual for hierarchical models notations are used [3].

In particular, we consider the laminated prismatic shell with the cross-section shown in Figure 1, its projection ω is a domain adjacent to axis x_1, the thickness of each layer has the form

$$2h(x_1, x_2) = h_0 x_2^{\kappa}, \quad h_0 = const > 0, \quad \kappa = const \geq 0, \quad (x_1, x_2) \in \omega,$$

with different constants involved there and each may have different elastic constants as well. For $\kappa > 0$ a layer is a cusped one [3]; for $\kappa = 0$, in particular, we have a layer of constant thickness.

Similar hierarchical models are constructed when on the face surfaces of the laminated body either displacement vector components or mixed stress and displacement vector components are assumed to be known. The analysis of well-posedness of boundary value problems, in general, non-classical ones, is carried out.

ACKNOWLEDGEMENT. The work was supported by the SRNSF grant # 30/28.

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ANALYTICAL SOLUTION OF CLASSICAL AND NON-CLASSICAL BOUNDARY VALUE CONTACT PROBLEMS OF THERMOELASTICITY FOR MULTILAYER CYLINDRICAL BODIES CONSISTING OF COMPRESSIBLE AND INCOMPRESSIBLE LAYERS

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The paper is devoted to an analytical solution construction of some applied thermoelasticity problems for multilayer cylindrical bodies when some of the layers may consist of an incompressible elastic material. Analytical solutions are obtained for the mentioned problems and on their basis an appropriate program is developed.

For a body N-layer along the radial coordinate and bounded by coordinate surfaces of a circular cylindrical system of coordinates static thermoelastic equilibrium is considered. On the flat boundaries of the cylindrical body boundary conditions of either symmetrical or antisymmetrical continuous extension of the solution are imposed. Between the layers contact conditions of rigid, sliding or other contact type may be defined. On the upper and lower cylindrical boundary surfaces arbitrary boundary conditions are given. The stated problems are analytically solved by the method of separation of variables. A general expression of the solution by means of harmonic functions is used. The solution of the involved problems is reduced to the solution of systems of linear algebraic equations with block-diagonal matrices.

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STABLE OF CONSTRUCTION MATERIAL BIJOND ELASTICITY

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One of important points of mechanics of solid bodes is description of inelastic strains. Possibilities of thermodynamics in this case are restricted. Therefore, it is necessary to use additional permissions.

In order to define inelastic deformations, additional postulates are usually introduced, that present reasonable limitations. There is stable postulate of material. Introduction of stable postulate allows to obtain constitutive relations.

For description of inelastic strain of construction materials Druckers postulate of stable [1] and Iliushins postulate of plasticity [2] is used. These postulates are formulated for isothermal processes of deformation.

According to Drucker/s postulate the work of additional stresses is positive if plastic strain is change and equal zero during passive deformation.

$$\oint_{\gamma} (\sigma_{ij} - \sigma_{ij}^{0}) \ d\varepsilon_{ij} \geq 0 \qquad (1)$$

Where $\sigma_{ij}, \sigma_{ij}^{0}$ are components of real and possible stress.

According to Iliushin/s postulate of plasticity the work of stress on closed curve equals zero if plastic strain is constant and is positive, if plastic strain is variable:

$$\oint_{\varepsilon} \sigma_{ij} d\varepsilon_{ij} \geq 0 \qquad (2)$$

Where σ_{ij} are components of full stress.

Above-mentioned postulates of stable of materials performance are generalization of experimental data. generalization of experimental data performance is also stable condition of construction materials during thermo mechanical loading: by thermo

mechanical loading on closed curve in the stress-temperature space integral is nonnegative:

$$\oint (\sigma_{ij} - \sigma_{ij}^{0}) d\varepsilon_{ij} + a_{ij} (\varepsilon_{ij} - \varepsilon_{ij}^{0}) dT \geq 0 \qquad (3)$$

Here ε_{ij} are real strains corresponding to the real stress σ_{ij} , ε_{ij}^{0} is possible strain corresponding to the possible stress σ_{ij}^{0} .

The unification of two inequalities Planks and Fouriers is employed in thermodynamics of continuous media we obtain. As a result, Clauzius - Diugem inequality, which presents thermo dynamical axiom. Above-mentioned conditions lead to different extremal principles. From condition (1) there follows a gradient flow. Condition (3) gives possibility to describe a non gradient flow.

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ANALYTICAL DESCRIPTION OF THE SLIDING SURFACES OF THE LANDSLIDE-COLLAPSE MASS OF MOUNTAIN ROCKS

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The cases of losing mountain slopes stability or static or dynamic stability of the snow cover over such slopes causing landslide and collapses of slopes and snow avalanches are frequent.

The damage caused by losing of static or dynamic stability of artificial and natural slopes and avalanches is mostly the result of insufficient reliability of structures, lack of protection and non-optimally selected locations for them.

Most of the researchers think that the dangerous sliding surface of the mass collapsed from the slopes is circular-cylindrical (a circle radical in case of 2D problems) what is globally less likely and is only a crude approximation of a real dangerous sliding surface.

We will consider the problems of stability and instability of mountain rock slopes, which, for the first time, will give a pure analytical solution of the problem to define a curvilinear surface of dangerous sliding of the slope massifs collapses by maximally considering the natural conditions.

The general and partial derivative differential equations describing the given phenomenon, which are met by an equation of a limit equilibrium curve describing the dangerous sliding surface of a collapsed mass of the mountain loose rocks slopes (a case of a 2D problem) and equation of plane (3D problem). The equation of curve is written out in quadratures. The starting conditions to solve the partial derivative non-linear equation are identified and general and specific solutions are constructed.

The mountain rock landslide massif is presented as a quasi-compact body, with its shearing and sliding conditions parametrically determined by such mechanical parameters of loose bodies, such as an angle of internal friction, volume weight and adherence, as well as limit equilibrium conditions of the properties of relations between the shearing plane and main stresses. An equation of a sliding curve for specific and general values of the adherence coefficient are gained and investigation for all cases of possible asymptotic properties of integral curves is carried out..

The goal of the project is to develop new thorough methods to calculate the slope stability, which are simple to use in the engineering practice and are based on the determination of the mode of deformation of a slope, application of some or other mathematical model for the ground by strictly considering all acting forces, as well as to consider the variation of the ground properties and identify the shape and location of possible sliding surfaces.

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ON THE CONSTRUCTION OF THE ALGORITHM OF THE NUMERICAL COMPUTATION FOR ONE HIERARCHICAL MODEL OF CUSPED PRISMATIC SHELLS

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We consider the following equation:

$$\rho h_1(x)\frac{\partial^2 u}{\partial t^2} = \mu\frac{\partial}{\partial x}\left(h_1(x)\frac{\partial u}{\partial x}\right) + \mu h_1(x)\frac{\partial^2 u}{\partial y^2} + f(x,y,t), \quad (1)$$

$$(x,y,t)\in\Omega\times]0,T],$$

where $\Omega =]0,1[\times]0,1[$, $h_1(x) = h_0 x^{\alpha}$, $h_0 > 0$, $0<\alpha<1$, ρ and μ are positive constants;

f(x , y ,t) is a sufficiently smooth function.

The equation (1) represents the particular case of initial approximation for hierarchical models of cusped prismatic shells [see [1]].

It is clear that due to the term $h_1(x)$ the given equation is degenerate and this creates an obstacle for its numerical realization.

We consider the standard initial-boundary value problem (with the Dirichlet boundary condition on $\partial\Omega$) for the equation (1). We look for the approximate solution using finite difference method. Let us cover the domain Ω by uniform grid. Denote the number of grid points by n $(n > 1)$, the mesh size by h, $h = 1/n$ and the grid points denote by (x_i, y_j)

$$(x_i, y_j) = (ih, jh) \text{ where } i, j = 0,1,\ldots,n.$$

Standard change of partial derivatives through difference quotients will possibly give no result. We suggest the following approach: integrate the both sides of the equation with respect to x in the interval $[x_{i-1/2}; x_{i+1/2}]$ and the integrals involving the degeneracy $h_1(x)$ calculate using the "partial" central rectangular formula:

$$\int_{x_{i-1/2}}^{x_{i+i/2}} h_1(x)\frac{\partial^2 u}{\partial t^2}dx = \left.\frac{\partial^2 u}{\partial t^2}\right|_{x=x_i} \int_{x_{i-1/2}}^{x_{i+i/2}} h_1(x)dx$$
$$= \left.\frac{\partial^2 u}{\partial t^2}\right|_{x=x_i} \frac{h_0}{\alpha+1}\left(x_{i+1/2}^{\alpha+1} - x_{i-1/2}^{\alpha+1}\right). \tag{2}$$

Similarly we should calculate the integral containing the second partial derivative with respect to y. In our opinion the application of these formulas will give better result then the direct application of the central rectangular formula. The basis for this argument is the fact, that the function under integral is not smooth due to the degeneracy of function $h_1(x)$.By the latter formulas we have avoided degeneracy in a certain sense.

The accuracy of the proposed formulas is expected to be the same as for the central rectangular formula (locally $O(h^3)$). Clearly we can calculate integral from f through the central rectangular formula.

On the next step we discretize the time argument t .Denote by τ the time step $\tau = T/m$ ($m > 1$ is a positive integer), the time grid points denote by t_k, $t_k = k\tau$.

Ultimately we shall get the following system of equations:

$$-a_i u_{i+1,j}^{k+1} + b_i u_{i,j}^{k+1} - a_{i-1}u_{i-1,j}^{k+1} = \mu\alpha_0\lambda_i\left(u_{i,j+1}^{k+1} + u_{i,j-1}^{k+1}\right) + d_{i,j} \tag{3}$$

where $i, j = 1,\ldots,n-1$, $k = 1,\ldots,m$, $a_i = \alpha_0 \nu_i$, $b_i = \lambda_i(\rho + 2\mu\alpha_0) + (a_i + a_{i-1})$,

$$\alpha_0 = \frac{1}{2}\left(\frac{h}{\tau}\right)^2, \quad \lambda_i = \frac{h_0}{\alpha+1}\cdot\frac{x_{i+1/2}^{\alpha+1} - x_{i-1/2}^{\alpha+1}}{h}, \quad \nu_i = \mu h_1(x_{i+1/2}),$$
$$d_{i,j} = (2\rho\lambda_i)u_{i,j}^k - \left(-a_i u_{i+1,j}^{k-1} + b_i u_{i,j}^{k-1} - a_{i-1}u_{i-1,j}^{k-1}\right)$$
$$+ \mu\alpha_0\lambda_i\left(u_{i,j+1}^{k-1} + u_{i,j-1}^{k-1}\right).$$

We declare the solution $u_{i,j}^k$ of the system (3) as the approximate value at the point (x_i, y_j, t_k) of the exact solution $u(x, y, t)$, $u(x_i, y_j, t_k) \approx u_{i,j}^k$. We solve the system (3) by factorization method combined with Zeidel iterative method. The numerical calculations based on the proposed algorithm give sufficiently good approximations for the different model problems.

Acknowledgment. The work was supported by the SRNSF grant #D-13/18.

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ON APPLICATION OF I. VEKUA'S METHOD FOR GEOMETRICALLY NONLINEAR NON-SHALLOW SPHERICAL SHELLS

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In this paper we consider geometrically nonlinear non-shallow spherical shells. By means of I. Vekua method the system of equilibrium equations in two variables is obtained [1, 2]. Using complex variable functions and the method of the small parameter approximate solutions are constructed for $N = 1$ in the hierarchy by I. Vekua. The concrete problem is solved.

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HERITAGE OF V.KUPRADZE IN 3D ELASTICITY: POTENTIAL METHOD AND FUNDAMENTAL SOLUTIONS METHODS (V. KUPRADZE-110)

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The presentation concerns the scientific heritage of Professor Viktor Kupradze in the linear theory of three-dimensional elasticity. We will consider two main directions:

(i) Development of potential method for spatial problems of elasticity and

(ii) Method of fundamental solutions.

We describe main achievements of the worldwide known school of V. Kupradze in the theoretical study of boundary value problems of elastostatics, elastodymanics and elastic vibrations based on the boundary integral equations methods.

We give also an overview of results related to the universal and easily realizable numerical method, method of fundamental solutions.

In the final part, we describe some new developments of the potential theory and treat some open problems.

ON ONE METHOD OF APPROXIMATE SOLUTION OF A PROBLEM OF THE RECTANGULAR PLATE DEFLECTION BY THIN RIGID INCLUSION

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In the papers [1,2] a problem of the rectangular plate deflection by thin rigid inclusion are brought to the smooth heart first type integral equation. Solution of this equation is defined in the singularized not integrated function class. It is possible that Jump function $\Psi(x)$ has the following not integrated singularity

$$\Psi(x) = (x - c_1)^{-3/2} (c_2 - x)^{-3/2} \Psi_0(x).$$

The obtained integral equation in the papers [1,2] was solved by the spectral (orthogonal polynomials) method, namely Jacobs' orthogonal polynomials was used.

In this paper for approximate solution of the above mentioned integral equation a new algorithm using collocation method is suggested. Namely in this paper in case of uniformly ranged net a discrete singularity method [3] is used. By analogy with [1.2] we assumed that plane border is articulate leaned.

By numerical calculations influence of the thin rigid inclusion's length and mass on the values of the deflection function was investigated.

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ON THE CALCULATION OF FLAT TAPERED FIGURES ON THE BASIS OF REPRESENTATION OF SOLID ELASTIC BODIES BY DISCRETE BAR STRUCTURES

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In this talk the results of one of the tasks of the grant project (SRNSF # 30/28) – Modeling and calculation of tapered (cusped) flat bodies on the basis of representation of solid deformable bodies by means of combinations of discrete bar structures - are presented.

Acknowlegment. This work was supported by Shota Rustaveli National Science Foundation (Grant # 30/28).

MECHANICAL BEHAVIOUR OF CONCRETE STRUCTURES REINFORCED BY COMPOSITES

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The strength, deformability and stability of concrete columns reinforced by carbon composites are considered. The formulas for prediction of ultimate strength, ultimate strain, and the tangent modulus above the limit of nonlinearity are derived and discussed. Comparison with the experimental data available in the published literature is done. The strengthening of reinforced concrete columns are considered. The loss of stability of columns above the strength of plain concrete is analyzed and it is proved that composite strengthening is efficient only for columns having low or moderate slenderness.

Acknowlegment. This work was supported by project of Latvian Council of Science # 214/2013 "Analysis and optimization of fiber reinforced concrete composition".

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SOME CONTACT PROBLEMS OF VISCOELASTICITY THEORY

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The solution of integral differential equation associated to the problem of the contact interaction of thin elastic semi-infinite element with a plane is constructed, the plane material has the creep property and the elastic and geometric parameters of the inclusion along its length vary according to a power law. In moment τ_0 the inclusion is loaded with only tangential $q_0(t,x)$ or only normal $p_0(t,x)$ forces.

It is required to determine the law of distribution of tangential $q\,(t,x)$ and normal $p(t,x)$ contact stress along the contact line, the asymptotic behavior of those stresses at the ends of inclusion and the coefficients of their intensities..

For determination of the unknown contact stress we obtain the following integral equations

$$-\frac{2(1-\nu^2)}{\pi E_2}\int_0^\infty \frac{q(t,y)dy}{y-x}+\frac{2(1-\nu^2)}{\pi E_2}\int_{\tau_0}^t K(t+\rho_2,\ \ \tau+\rho_2)d\tau\int_0^\infty \frac{q(\tau,y)dy}{y-x}=$$

$$=-\frac{1}{E_s(x)}\int_0^x [q\ \ (t,y)-q_0(t,y)]dy, \qquad x>0$$

$$-\frac{2(1-\nu^2)}{\pi E_2}\frac{d^2}{dx^2}D(x)\frac{d}{dx}\{\int_0^\infty \frac{p(t,y)dy}{y-x}-$$

$$\int_{\tau_0}^t K(t+\rho_2,\ \ \tau+\rho_2)d\tau\int_0^\infty \frac{p(\tau,y)dy}{y-x}\}=$$

$$=p_0(t,x)-p(t,x), \qquad x>0$$

where

$$K(t,\tau)=E_2\frac{\partial C(t,\tau)}{\partial\tau}, \quad \rho_2=\tau_2-\tau_0, \quad E_s(x)=\frac{E_1(x)h(x)}{1-\nu_1^2},$$

$C(t,\tau)=\varphi_2(\tau)[1-e^{-\gamma(t-\tau)}]$ is measure of creep of plane material, $\tau_2(x)=const$ is age of material, ν_1 is Poisson's ratio and $E_1(x)$ is the elastic modulus of the material of inclusion , $h(x)$ is its thickness, $D(x)$ is cylindrical rigidity of inclusion.

The equilibrium conditions for inclusion have the form

$$\int_0^\infty [q(t,y)-q_0(t,y)]dy=0 \qquad \int_0^\infty [p(t,y)-p_0(t,y)]dy=0,$$

$$\int_0^\infty y[p(t,y)-p_0(t,y)]dy=0.$$

ON ONE EFFECTIVE SOLUTION OF SOME BOUNDARY VALUE PROBLEM OF STATICS OF THE THEORY OF ELASTIC MIXTURE FOR A HALF-PLANE

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In the present work it is shown that the effective solution of some boundary value problems of statics in the linear theory of elastic mixture for a half-plane can be reduced in some domain to the Dirichlet problem for equations of the Laplace and Poisson and on the of Neumann problem for equation of the Poisson.

SOME FRAGMENTS OF DEVELOPMENT Of SOLID MECHANICS

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In this talk, which is a kind of a survey, comprising half a century period, some mathematical problems of nonlinear mechanics of solids are considered. Problems connected with exstension and justification of some classical results of linear theory of elasticity for isotropic homogeneous bodies and numerical realizations of thermo-dynamics of anisotropic nonhomogeneous not only elastic media will be stated. A part of this work will be reported acording to [1], pp.195-240.

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DETERMINING OF THE TENSE-DEFORMING CONDITION OF ANISOTROPIC PRISMAL BODY IN CASE OF BENDING BY LATERAL FORCES

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In the work the problem of stress-strain state of the right-angled section anisotropic prismatic body is studied in case of bending by lateral forces. Without the usage of assuming hypothesis (among them the Saint-Venant way) an exact solution of the problem is given with the use of a new theory, dealing with a general science of continuous bodies, created by I.Ghudushauri. The components of internal strain and displacement are found, which satisfy the initial and boundary value conditions, the physical equations and the equations of equilibrium.

Mechanics of Fluids

ABOUT THE POSSIBILITY OF ENERGY GENERATION FROM THE EQUILIBRIUM ENVIRONMENT

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The paper draws attention to the fact that reports about energy production from the equilibrium space (in particular from the vacuum) has a strong theoretical basis and these phenomena can not be explained on the basis of classical equilibrium thermodynamics, which does not take into account the complex structure of matter and its ability to internal circulation (accumulation and release) of energy...

These phenomena in an isolated system may cause erratic decrease in entropy. The classification of processes that can be termed as implosion is given. (For the first time this term is used by Shauberger).

From the standpoint of the discrete structure of universe, all bodies and systems are in disequilibrium or conditional equilibrium state. Consequently, the equilibrium, phenomenological thermo-dynamics and theory of Carnot are true for processes that, in principle, do not exist in nature.

Following the second law of thermodynamics, if in the system of physical bodies at a certain temperature, a chemical reaction with heat absorption is carried out, the reverse reaction with heat release will be carried out only at the same or lowest temperature. As far as is known, the validity of this principle has not been proved and can not be proved, since, in fact, the opposite effects are found.

By author is shown that if in the thermodynamic cycle, at a specific temperature, is carried out implosion (For example, process with heat absorption, generation of turbulence or cavitation and others) and the reverse process with heat release (dissipation) occurs at a higher temperature, the thermodynamic cycle will continuously generate usable energy from the heat. As an example is stated the water decay and reverse synthesis cycle and is shown that the water thus becomes in a source of heat and mechanical energy, although, in reality, at this

is consumed the environmental heat or another kind of energy (in particular, vacuum energy).

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MODELING LITHODYNAMIC PROCESSES IN THE COASTAL ZONE

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The beach topography change in the nearshore zone may be induced by natural phenomena such as wind, wave, storm,tsunami, and sea level rise. However, it can also be caused by man-made structures and activities, for example, groins,detached breakwaters, seawalls, dredging, and beach nourishment. Therefore, understanding the beach topography evolution in this zone is necessary and important for coastal engineering projects, *e.g.*, constructing harbors, maintaining navigation channels, and protecting the beach against erosion.

During the latest decade, advanced numerical models have been used as useful tools for simulating the beach morphological evolution. A number of such numerical models have been developed and applied through the years in many practical applications. However, the hydrodynamical and morphological processes are extremely complex in the nearshore zone and still beyond our current knowledge to describe in detail. Thus, these numerical models often include a limited set of processes characterized by certain time and space scales. Furthermore, high-quality and synchronized data sets from laboratories and the field are also limited, making model validation difficult.

The overall objective of this study was to develop a robust and reliable numerical model of beach topography evolution due to waves and currents with the emphasis on the impact of coastal structures. Such a model should describe the effects of both longshore and cross-shore sediment transport over time scales from individual storms to seasonal variations. In order to facilitate this, a number of sub-models were developed and improved, including (1) a random wave transformation model, (2) a surface roller model, (3) a nearshore wave-induced current model, (4) a sediment transport model, and (5) a morphological evolution model.

The obtained results predicted by the numerical model were satisfactory and in good agreement with measurements. The simulations showed that the calculated wave conditions and longshore current were well reproduced for all investigated test cases with and without structures. The calculated cross-shore current somewhat underestimated the measurements, however,it was in good agreement with observations in the lee of structures. Although the calculated wave setup overestimated observations, the absolute differences between calculations and measurements were relatively small. The predictions of beach morphological evolution under waves and currents in the vicinity of a detached breakwater and a T-head groin agreed rather well with measurements. Both salient and tombolo formation behind these structures were well reproduced by the numerical model. In the future, the model will be further validated against available data from the laboratory and the field.

However, already in its current state it is expected that the model can be applied in coastal engineering projects for predicting the beach evolution in the vicinity of coastal structures with some confidence.

LARGE SCALE ZONAL FLOWS' AND MAGNETIC FIELD GENERATION BY SMALL SCALE TURBULENCE IN THE IONOSPHERE

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In the present work, the generation of large-scale zonal flows and magnetic field by short-scale collisionless electron skin depth order drift-Alfven turbulence in the ionosphere is investigated. Evolution equations for the shear flows and the magnetic field is obtained by means of the averaging of model equations for the fast-high-frequency and small-scale fluctuations. It is shown that the large-scale disturbances of plasma motion and magnetic field are spontaneously generated by small-scale drift-Alfven wave turbulence through the nonlinear action of the stresses of Reynolds and Maxwell. Positive feedback in the system is achieved via modulation of the skin size drift-Alfven waves by the large-scale zonal flow and/or by the excited large-scale magnetic field. As a result, the propagation of small-scale wave packets in the ionospheric medium is accompanied by low-frequency, long-wave disturbances generated by parametric instability. Two regimes of this instability, resonance kinetic and hydrodynamic ones, are studied. The increments of the corresponding instabilities are also found. The conditions for the instability development and possibility of the generation of large-scale structures are determined. The instability pumps the energy of primarily small-scale Alfven waves into that of the large-scale zonal structures which is typical for an inverse turbulent cascade.

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MATHEMATICAL MODELING OF NATURAL GAS FLOW IN PIPELINES WITH FORMATION OF HYDRITES

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Nowadays pipelines have become the most popular means for natural gas transportation. Main reasons of pipeline constipation (emergency shutdown) are the following: generation of hydrates, freezing of water slugs, contamination and so on. Unfortunately practice shows that while natural gas is transported by pipelines changeability of gas pressure and temperature are causing formation of the gas liquid phase. There are several methods for avoiding gas hydrate problems: injection of thermodynamic inhibitors, use of kinetic hydrate inhibitors to sufficiently delay hydrate nucleation/intensification, and maintain pipeline operating conditions outside the hydrate stability zone by insulation, heating and controlling pressure. However, the above techniques needs knowledge of hydrates formation localization otherwise they may not be economical and practical. To take timely steps against generating of hydrates, it is necessary to study humidity and distribution of pressure and temperature. From existing methods the mathematical

modeling with hydrodynamic method is more acceptable as it is very cheap and reliable and has high sensitive and operative features. In the present paper the problem of prediction of possible points of hydrates origin in the main pipelines taking into consideration gas non-stationary flow and heat exchange with medium is studied. For solving the problem of possible generation point of condensate in the pipeline under the conditions of non-stationary flow in main gas pipe-line the system of partial differential equations describing the hydrodynamics and thermal physics of a flow in the gas main in the presence of deposits of gas hydrate is investigated. Some results of numerical calculations for emergency detection are presented. Numerical calculations have shown efficiency of the suggested method.

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THE GENERALIZED INTEGRAL RELATIONS FOR BOUNDARY LAYER

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We will restrict ourselves to the consideration of radiative-convective heat transfer within the thermal boundary layer. The mathematical model of heat transfer between the working medium and the wall is based on the following assumptions.

1. The working medium is a gray body whose temperature is equal to the temperature beyond the boundary T_∞.
2. The radiation transfer in the longitudinal direction of the boundary layer is not considered.
3. The emissivity factor ε of gas is pre-assigned on the basis of an empirical relation. The emissivity factor of wall surface [1] is taken to be constant.

4. The rate of leakage of working medium (which radiates and absorbs the thermal energy) on the r surface is preassigned from the theory [1].
5. The problem of the flow of working medium past the surface is treated in the axisymmetric (proceeding from the geometric shape) and quasi-steady-state (proceeding from the value of Strouhal number Sh<<1 formulation.

The equation system for the dynamic and thermal boundary layers of a gas which radiates and absorbs the thermal energy and flows over a curvilinear surface has the form [1]

$$\begin{cases} \frac{\partial}{\partial x}\left(H_3 u\right)+\frac{\partial}{\partial y}\left(H_1 H_3 v\right)=0; \\ \rho\left(\frac{u}{H_1}\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}+\frac{uv}{H_1}\frac{\partial H_1}{\partial y}\right)= \\ -\frac{1}{H_1}\frac{\partial p}{\partial x}+\frac{1}{H_1^2 H_3}\frac{\partial}{\partial y}\left(H_1^2 H_3 \tau_T\right); \\ \rho\frac{u^2}{H_1}\frac{\partial H_1}{\partial y}=\frac{\partial p}{\partial y}; \\ H_3 u\frac{\partial T}{\partial x}+H_1 H_3 v\frac{\partial T}{\partial y}=\frac{1}{\rho c_p}\frac{\partial}{\partial y}\left[H_1 H_3\left(q_k+q_r+\tau_T u\right)\right]; \\ \frac{\partial E_+}{\partial y}=\beta\kappa\left(\sigma_0 T^4-E_+\right); \\ -\frac{\partial E_-}{\partial y}=\beta\kappa\left(\sigma_0 T^4-E_-\right) \end{cases} \qquad (1)$$

and the boundary conditions have the form

$$y=0,\ u=v=0,\ \tau_T=\tau_w,\ T=T_w,\ E_+=E_+(0),\ E_-=E_-(0);$$
$$y=\delta_m,\ u=u_m,\ \tau_T=0; \quad (2)$$
$$y=\delta_T,\ T=T_\infty;$$
$$y=\delta,\ u=0,\ \tau_T=0.$$

In these expressions, p is the pressure; ρ is the density; T is the temperature; u and v are components of velocity vector in the

longitudinal x and transverse y directions, respectively; τ_T is the friction stress; $\tau_W=\tau_T\big|_{y=0}$ is the friction stress on the wall; $q\ c$ and $q\ r$ denote the density of convective and radiative heat fluxes, respectively; and $H_i^2=\left(\frac{\partial x}{\partial q_i}\right)^2+\left(\frac{\partial y}{\partial q_i}\right)^2+\left(\frac{\partial z}{\partial q_i}\right)^2$ $(i=1,2,3)$ denotes the Lame coefficients which relate the arbitrary orthogonal curvilinear coordinates $q_1(x, y, z)$, $q_2(x, y, z)$, $q_3(x, y, z)$ with Cartesian coordinates x, y, z. Since the problem is solved in the axisymmetric formulation, H_2 is absent from Eqs. (1). The radiative heat flux along the *y*-axis is $q_r=E_+-E_-$ where E_+ and E_- denote the radiation flux density along the *y*-axis and in the opposite direction, respectively.

Selected as a basis for the solution of the problem system represents the integral method, which exhibits a number of advantages over the direct numerical solution of the equation system (1) by any one of the known methods [2, 3, 4, 5]. The method of integral relations implies the use of integral characteristics of boundary layer such as displacement thickness, momentum thickness, and enthalpy thickness. These characteristics have the significant property of invariance in the case of the upper limit of integration varying from $y=\delta_m$ to infinity [2]. Also an advantage of the method of integral relations consists in the reduction of the effect made on the end result by the errors associated with the use of semiempirical dependences for □*w* known from thermophysics (for example, the profile of velocity or turbulent friction stress has not been yet determined directly for thin boundary layer in working modes in piston engines). In addition, the use of the integral method enables one to replace the problem with partial differential equations by that with integral-differential equations of shear stresses of friction, velocities, and temperature may be used to reduce the latter equations to ordinary differential equations whose solutions satisfy the initial equation system (1) and boundary conditions (2).

The generalized integral relations, obtained by way of integration of equations of motion for hydrodynamic boundary layer and of energy for thermal boundary layer on the coordinate y within the boundary layer, have the form

$$\left[1-\left(\frac{2a^2+3a+1}{a}\right)^2\frac{\partial H_1}{\partial y}\,\delta^{**}\right]\frac{d\delta^{**}}{dx}-$$

$$\left(\frac{1}{a}\frac{1}{u_m}\frac{du_m}{dx}+\frac{1}{H_3}\frac{\partial H_3}{\partial x}\right)\delta^{**}-$$

$$-A\left(\frac{2a^2+3a+1}{a}\right)^{-b}\nu^b u_m^{-b}\left(\delta^{**}\right)^{-b}=0 \qquad (3)$$

$$\frac{d}{dx}\left[H_{30}u_m\left(T_\infty-T_w\right)\delta_T^{**}\right]=\frac{H_{30}}{\rho c_p}\left[q_{kw}+\left(E_--E_+\right)\Big|_0^{\delta_T}\right], \qquad (4)$$

here, $\delta^{**}\overset{def}{=}\int_0^{\delta_m}\frac{u}{u_m}\left(1-\frac{u}{u_m}\right)dy$ is the momentum thickness, $\delta_T^{**}\overset{def}{=}\int_0^{\delta_T}\frac{u}{u_m}\left(1-\frac{T-T_w}{T_\infty-T_w}\right)dy$ is the enthalpy thickness, a is the exponent in the "power law" of distribution of velocity $\frac{u}{u_m}=\left(\frac{y}{\delta_m}\right)^a$ (its value corresponds to the condition of equivalence of the power and universal (logarithmic) laws of distribution), b is the exponent from the Blasius formula for friction stress $\tau_w=A\rho u_m^2\,\mathrm{Re}_m^{-b}$ (its value is related to the exponent a by the Karman condition a = b/(2 – b));□□ ν is the kinematic viscosity, $H_{30}=H\big|_{y=0}$, $q_{kw}=q_k\big|_{y=0}$ is the heat flux to the wall surface.

Integral conditions (3) and (4) are generalizations of the known integral conditions. Indeed, if we assume that that the surface curvature radius $r\to\infty$ and the radiative heat flux $q_r=(E_+-E_-)\big|_0^{\delta_T}=0$ the known integral relations of Karman and Kruzhilin–Polhausen [2] follow from Eqs. (3) and (4).

Thus, the generalized integral relations are obtained. The obtained results confirm the working capacity of the model.

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STRONG ANISOTROPIC VORTEX TURBULENCE SPECTRA IN GEOSPACE ENVIRONMENT

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The talk is devoted to the investigation of the macroscopic consequences of nonlinear vortex structures in magnetized space plasmas. Strongly localized vortex structures contain the trapped particles and, diffusing in the medium, cause appreciable density fluctuations and intensify heat transport processes, i.e., they can form the strong vortex turbulence. Turbulence is represented as gas of ensemble of the strongly localized (therefore weakly interacting) identical vortices creating the basic condition. The vortices with various amplitudes randomly distribute in space (due to collisions). The statistical approach is applied for their description. It is supposed that the stationary turbulent state is formed by balance of competitive effects: spontaneous birth of the vortices due to nonlinear curvature of the perturbations' fronts, noise pumping into the short scales and collisional or collisionless dampings of the perturbations into the short-waves area. Noise pumping according to scales in an inertial interval occurs due to structures' merging at their collision. The new spectrum of turbulent fluctuations according to wave numbers $k^{-8/3}$, which correlates well with experimental observation, is derived. For the magnetotail region the parameters of kinematic and magnetometer measurements by satellite "THEMIS" data are studied. Investigated spectra shows, that the power law index of these spectra are dependent on the magnetospheric state. Namely, in the time interval, studied by us, the form of the spectra is determined by magnetic storms in the magnetospheric region. Computer modeling of the interaction of plasma vortices was carried out, which proved the possibility of the scenario of proposed turbulent state formation.

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ON THE NAVIER-STOKES EQUATION IN SOME AXI-SYMMETRIC CASES

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The fluid flow over the axisymmetric bodies in case of low Reinolds number is considered. In this case the Navier-Stokes equation could be linearized and reduced to the Stokes linear equation with the appropriate initial-boundary conditions. In some specific cases the explicit formulas for the velocity of the flow and shear stresses are obtained. The case of changeable boundary is also considered.

NUMERICAL INVESTIGATION OF THE SEASONAL PECULIARITIES OF THE UPPER LAYER THERMAL MODE IN THE BLACK SEA

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The turbulent mixing layer of seas and oceans is one of the important water areas, the thermal state of which defines to a great extent not only processes of ocean-atmosphere interaction and climate formation, also it significantly influences the living marine organisms. The same can be noted concerning the Black Sea turbulent mixing layer, which undergoes significant variations in the inner-annual time scale.

Original barolinic 3-D numerical model (A. Kordzadze and D. Demetrashvili) have been used to simulate the Black Sea thermodynamic processes in the mixing layer of the Black Sea. Emphasis has been focused on estimation of variability of horizontal heat transport and thickness of mixing layer in conditions of the alternation of different wind types and monthly variability of atmospheric thermohaline forcing.

The analysis of the numerical experiments showed that distribution of temperature fields on the horizons in the upper mixing layer is connected generally with variability of atmospheric thermohaline forcing, but variations of the thickness of this layer mainly depend on circulation processes developed during the year.

On an example of January it is shown that in the cold season the thickness of the mixed layer is increasing. In this period above the Black sea alternation of strong winds is observed and temperature mixing processes within the homogenous 0-16m upper layer are strongly developed. In the warm season (approximately from middle April to the end of August), when weak winds are observed, the mixing layer of the Black Sea is thinnest.

ON THE TRANSITIONS BETWEEN TWO ROTATING POROUS CYLINDERS WITH RADIAL AND AXIAL PRESSURE GRADIENT

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The stability of viscous incompressible flow between two rotating porous cylinders with a radial and axial flows are investigated. This type of flow occurs in technical hydrodynamics connected with the problem of filtration and has special interest.

The first instability of main stationary flow occurred via either axisymmetric or nonaxisymmetric disturbances. In the first case the main flow is replaced by the secondary axisymmetric flow having the form of vortices. For nonaxisymmetric disturbances the secondary flow regime is a time-periodic flow with azimuthal waves.

The report presents the results of investigation of complex regimes arising in a vicinity of the intersection point of the neutral curves corresponding to two above mentioned kinds of instability.

UNSTEADY ROTATION PROBLEM ON INFINITE POROUS PLATE IN THE CONDUCTING FLUID WITH ACCOUNT OF MAGNETIC FIELD AND HEAT TRANSFER IN CASE OF VARIABLE ELECTRIC CONDUCTIVITY AND INJECTION VELOCITY

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By using the method of successive approximation we have studied the unsteady rotation problem on porous plate in a conducting fluid with account of magnetic field and heat transfer with variable electric conductivity $\sigma = \sigma_0 \frac{T}{T_0}$ and injection velocity $\upsilon_w = \upsilon_0 \frac{T}{T_0}$.

To determine the thickness of the dynamic and thermal boundary layers, differential equations are obtained and exact solutions were found in special cases when the injection velocity varies according to different laws and between the thicknesses of a functional dependence of the form $\delta_T(t) = \gamma\delta(t)$.

All physical characteristics of the flow are calculated.

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Applied Mechanics

MODELING OF WAVE PROCESSES IN THE COASTAL ZONE

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A numerical model of undertow due to random waves is developed. The model includes three sub-models: (1) a model for multi-directional and frequency random wave transformation, (2) a surface roller evolution model, and (3) a model for calculating the vertical distribution and the mean value of the undertow velocity. The calculation of wave trough level is estimated based on the theory of wave asymmetry. The model is expected to provide reliable input for the modeling of sediment transport and morphological changes due to waves and currents.

MATHEMATICAL MODELING OF BIOMECHANICAL SYSTEM EQUIPPED WITH RESCUE BACKPACK-LIKE DEVICE

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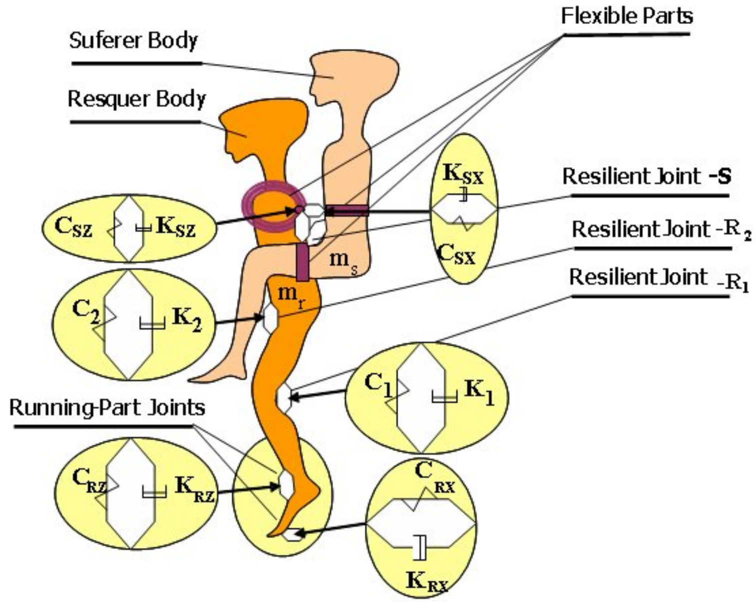
The intended for evacuation of sufferers in natural disasters and other emergency situations simple backpack-like innovative rescue-belt device ("know-how") represents the alternative to traditional hand-barrow (a stretcher) Besides, for military purposes, the company "Agilite Gear", manufacturer of tactical-purpose equipment, has developed the backpack-like rescue belt device [1, 2].

The backpack-like rescue-belt device redistributes a transported person's weight similarly to traditional sitting. Its mechanical structure is based on the newly created sample of a flexible loop [3].



The oscillating dynamic processes of biomechanical system are described by using the Lagrange second order differential equation system [4].

$$1.(M_r + M_s)\ddot{X}_R = (M_r + M_s)g - C_{RX}X_R - K_{RX}\dot{X}_R;$$

$$2.M_s\ddot{X}_S - C_{SX}(X_R - X_S) - K_{SX}(\dot{X}_R - \dot{X}_S) = 0;$$

$$3.(M_r + M_s)\ddot{Z}_{RP} = (M_r + M_s)g - C_{RZ}Z_{RP} - K_{RZ}\dot{Z}_{RP};$$

$$4.(M_r + M_s)\ddot{Z}_{RJR_1} - C_1\left(Z_{RJR_1} - Z_{RP}\right) - K_1\left(\dot{Z}_{RJR_1} - \dot{Z}_{RP}\right) = 0;$$

$$5.(M_r + M_s)\ddot{Z}_{RJR_2} - C_2\left(Z_{RJR_2} - Z_{RJR_1}\right) - K_2\left(\dot{Z}_{RJR_2} - \dot{Z}_{RJR_1}\right) = 0$$

$$6.M_s\ddot{Z}_{RJS} - C_{SZ}\left(Z_{RJS} - Z_{RJR_2}\right) - K_{SZ}\left(\dot{Z}_{RJS} - \dot{Z}_{RJR_2}\right) = 0.$$

The proposed backpack-like rescue-belt device can be used in the passages blocked up by ruins, narrow ravines with complicated landscape and under other extreme conditions of complicated movement - without special training.

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THE STRUCTURE AND WORKING ANALYSIS OF CRAN_TRANSPORT AND TRAFFIC CARS

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The crane-transport and traffic car's machinery equipment represent the area of systems, which demands precision of instruments, due to which in every ring, stress may be minimal.

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THE MATHEMATICAL MODEL OF STUDIES OF THE EXTENT OF THE INFLUENCE OF FACTORS ACTING ON EXHAUST GAS HEAT EXCHANGE PROCESS

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The exhaust gas heat exchange process occurs under considerable influence of numerous factors such as: changes in speed of movement, mass and temperature of the combustion products, and thickness of soot settled to the surface of heat exchanger. Analyzing the dynamic motion of exhaust gases in exhaust system, which directly depends on the engine operating condition, we see that the amount of its heat energy is changeable and the current heat exchange processes are unsteady that directly depends on the unsteadiness nature of the motion speed of flow, changeability of mass and temperature of flow, thickness of sediments of the combustion products on the surface of heat-exchanger and on the flow pulsation nature and so on. Thus, while utilizing burnt-out gases heat energy in calculation of heat-exchange process, it is necessary to take account of the influence of the engine operating conditions – the value the transient flow of heat and of thickness of sediments of the combustion products on the surface of heat-exchanger. The mathematical model for the selected tube and rib compact heat exchanger is developed, which describes the heat-exchange process from the hot heat carrier (exhaust gases) to the cold one (coolant), and we obtain the equation system. By inserting and integrating known quantities into the equation system, the mathematical model of heat transfer process of the exhaust gases' heat energy is obtained, which determines the flow of heat on the i-section of heat exchange process.

In order to calculate heat exchange process and select the compact heat-exchanger, it is necessary to analyze the following four geometrical parameters:

- equivalent diameter – depends on a free area and single channel perimeter, which is formed between two neighboring ribs;

- volume-to-size ratio – depends on the entire surface and volume of heat-exchanger, which is placed in the ribbing space;
- free area ratio - depends on a free area and the entire face area of the ribbing space; this ratio characterizes filling of section in the cross-section of ribs;
- specific ribbing area - depends on the entire surface of ribs and heat-exchanger, which characterizes heat transfer from the ribbing space share from the heat transfer surface area.

The characteristic sizes and parameter describe ribbing property of a particular heat-exchanger with no conditions. At the same time in this case, there are easily obtained those geometrical parameters of heat-exchanger, which are used in their calculations. The hydraulic characterizes of heat-exchanger are noteworthy as well, which describe the pressure loss value, which is spent on the arisen flow regime for increasing intensity of heat transfer process.

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SHELLS DEFORMABILITY AND STABILITY OF SPATIAL SYSTEMS WITH DISCONTINUOUS PARAMETERS

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Considered are review works on stability analysis analytical methods with taking into account the geometrical non-linearity and stability of plates, which have the discontinuities of regularity. Due to the consideration of these non-regularities generalized functions are applied that will be introduced in initial geometrical and physical relations. The solution of obtained differential equations with pulse

coefficients are presented by combination of regular and discontinuous functions that leads to rapidly divergence series and simple computational algorithms.

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THE INFLUENCE OF LIGHTING ON THE THREE-DIMENSIONAL SOLUTION OF THE BUILDING STRUQTURE

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When projecting figures on a plane between the figure and its projection with a combination of flat fields, there is various related correspondence. This establishes a correspondence between, for example, a combined plan and shadow shapes on the frontal plane. Analyzing the construction of the shadow of a horizontal circle on the frontal plane, usually carried out by the method of removal, we can see that the basis of this method is the shift transformation, which transforms the circle into an ellipse.

Surface can be represented as the envelope of its tangent planes. Moving a tangent plane for some direction touch points leave a trace of the points of contact on the surface. Direction of the received line which is called the characteristic is, in a certain way, connected with the displacement direction of the tangent plane. Note that if the surface is described approximately by a developable surface, the tangent line of contact and generator of a developable surface are aligned on the surface.

When building of their own and drop shadows of surfaces amazing relationship of affine, projective and differential patterns in their practical aspect is found. The development of these patterns on the example of building their own and drop shadows of a surface of revolution are considered. The results are applicable to more general cases with arbitrary shadowing light. At first, we study a special case for a cone of revolution by lighting parallel to the frontal plane projections. The projection of the outline shadow generator is determined as the fourth harmonic to the given generator and direction of the light beam.

Graphic algorithm of constructing of shadow points by holding of straight lines respectively perpendicular or parallel to the direction of the light beam and outline generator is installed. On this basis, obtain a functional relation between the coordinate of the desired point with the radius of the base of the cone, angles of the light beam, and the distance to the generator, as well as the relationship between the direction of the beam of light and its projections.

INVESTIGATION OF ROCK's FIELD OF TENSION UNDER ROLLING LOADS ON ITS SURFACE

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In the paper it has been proposed mathematical model, according which rock is considered an orthotropic half-plane, on which boundary rolling loads exert pressure with constant v velocity ($v<c_1$, $v<c_2$, c_1 and c_2 are velocities of shear and compressional wave propagation) (Fig.1).

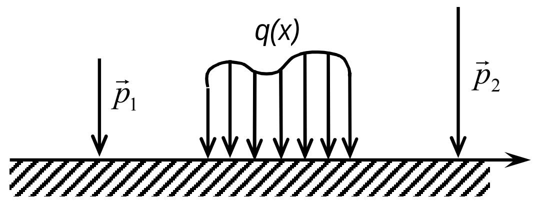

Fig.1

The mathematical problem has been studied and solved by complex variable and theory of analytical functions. Particularly, the analog of Airy stress function has been written and analytical functions of $F_1(z_1)$ and $F_2(z_2)$ ($z_1=\xi_1+i\eta_1$, $z_2=\xi_2+i\eta_2$; $\xi_1+\xi_2=x-vt$; $\eta_1=(1-v^2/c_1^2)^{1/2}$; $\eta_2=(1-v^2/c_2^2)^{1/2}$) have been found, by which stress and displacement components are expressed analytically. Stated formulas enable to find stress-strain behavior of rock.

The problem considered is interesting on both mathematical and practical grounds.

ROLE OF RESIDUAL STRESSES IN THE DESTRUCTION OF PIPELINES

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In the welding and surfacing as a result of uneven volume changes stresses are formed, which may be caused by different phenomena. These internal stresses can cause not only the deformation of the structure, but also its destruction [1-3]. Such cases are particularly dangerous for the ecology of the environment in the production and operation of complex welded structures of large dimensions. Such structures are large-diameter pipelines, in particular, oil and gas pipelines. A large number of accidents are annually fixed there.

The main cause of accidents networks of pipelines is often the corrosion of base metal and welded joints, which is particularly dangerous in the presence of internal stresses in the structure, as they can develop stress-corrosion cracking under stress. As indicated in [3], up to 40 % of accidents occur as a result of corrosion cracking. Almost half of the destruction of pipelines occur in the weld zone, the cause of which is the presence of local residual welding stresses. When these residual stresses in the pipe are added to the operating stresses crack in the weld zone can be accelerated and cause the crack growth stage up to the destruction of the pipeline. This process is particularly intense in the development of corrosion phenomena.

As the research results, the presence of residual stresses in the welds and base metal of welded pipes of large diameters was found. The values of residual stresses at individual points reaches the yield stress of the base metal. Residual stresses when applied to the operating stresses significantly increase the total stresses, which accelerates the corrosion process of pipelines destruction. Residual stresses as applied to the operating stresses significantly increases the total stresses, which accelerates the corrosion process of destruction of pipelines. Therefore, it is necessary to develop ways of reducing the residual welding stresses in pipes.

There are numerous methods to reduce the residual welding stresses: forging, compression, vibration, shock, sonication, local and volume heat treatment, and others. Very good results are obtained by using methods of thermal treatment.

In addition, there is a need to influence the value of residual stresses in the pipes to reduce it using welding materials with better properties. For this purpose is carried out research to develop a welding wire, which allows to create the weld residual stress or compressive or tensile values far (sometimes even 5 times) lower than the existing technology.

Investigations were carried out on steels and 17Г1С and 15ХСНД using welding wire Св-08Г2С and Св-08ХМ (ferrite-pearlite), Св-06Х19Н9Т (austenitic) and flux-cored wire designed martensitic structure (4.5-5.5% nickel, 0 5-0,6% , chrome, 0.3-0.5% molybdenum, 1.3-1.5% manganese, 0.3-0.4% silicon, 0,14-0,2% vanadium, yttrium≤ 0,019 %, carbon≤ 0,05%, iron - balance). As protective atmosphere carbon dioxide was used, welding fluxes grades АН-60 and АН- 348.

Mechanical test specimens welded with wire of the above composition indicated that the toughness of the weld metal toughness equivalent to the base metal and technological strength completely satisfies the regulatory requirements for welded pipes.

In [4] investigated is the possibility of reducing the residual stress and increasing the technological and structural strength of the weld through the creation of physical and chemical heterogeneity on the length of the seam.

The experiments were performed on steels 17Г1С and 15ХСНД using welding wire Св-08ХМ, Св-06Х19Н9Т and cored wire with alternating cyclic structure (Св-08ХМ+Св-06Х19Н9Т) in defense of the gas and submerged АН- 348. It was assumed that the increase in the resistance against the weld cracking is possible through the use of variable - cycle material composition through the relaxation of welding stresses. In this case, residual stress reduced by 2-4 times compared with stitches, made pearlitic and austenitic materials.

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SOME NON-TRADITIONAL ASPECTS OF CLASSICAL DESCRIPTIVE GEOMETRY

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Modeling of many physical, biological, chemical, and other phenomena often leads to different geometric forms and transformations of higher orders. Geometric modeling is characterized as a field of research related to the questions of constructing models of spaces and its objects, including the methods of descriptive geometry. When choosing a method of classical descriptive geometry are of interest four questions: how the initial set of mappings is represented, which is a region of arrival, which set is the starting point for constructing the arrival area, and by what rule elements of departure and arrival areas (prototypes and images) are matched. The questions of prototypes and images setting in different methods of descriptive geometry are considered: in the method of two tracks, in the projections of numerical marks, in the Gaspard Monge`s method, in perspective, in axonometric, in the Fiedler`s cyclographs, in stereographic projection of the sphere, in the Major`s paintings method etc. In the construction of reversible maps those expressions are shown whose mapping area is a Cartesian set or its subset. Depending on the choice of prototypes and images, four main areas of geometric modeling are described.

THE ROLE OF NANO-SIZE PRECIPITATIONS IN Ti- AND Al-BASED ALLOYS SUBJECTED TO SEVERE EXTERNAL IMPACTS

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The paper is devoted to investigation of severe external impacts for surface and volume nanostructuring of structure metal materials [1]. The investigated materials are Ti- and Al-based alloys: Ti-Nb, Ti-Ni and D16, AD31, correspondingly. External impacts are presented by large plastic deformation and powerful pulse current. Phenomenological features of various effects (structure refinement, phase transformations, separation-dissolution, stress jumps and deformability) are investigated at a simultaneous or consecutive combination of plastic deformation and external influences [2]. One of new processes in this area is electroplastic deformation – EPD [3]. Electropulse treatment by powerful current also can be used as an independent method for a structure relaxation and healing of microdefects [4].

As contrasted to known approaches of nanostructuring only in volume or only on surface, the problem of gradient nanostructure with the changing size of nanograins from the sample center to its surface is solved in the work. Definition of critical parameters of intensive external impacts and its influence on the structure elements, responsible for functional properties and their stability not only in the material, but also in a product, is a main objective of the present paper.

Physical, mechanical, functional properties and structure evolution in the processed states are investigated by special techniques. Ratio of “process-microstructure-properties” for the investigated alloys is discussed.

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STUDIES OF TOTAL ENERGY USE FOR HEATING OF OIL MOVING THROUGH PIPELINE

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The oil is extracted from beneath the ground through the boreholes and its transportation is carried out by pipeline transport at several hundred kilometers under the conditions of certain pressure and temperature.

Viscosity is a major physical-chemical parameter of oil, and it considerably determines the speed of oil movement through pipeline. And viscosity itself is a value considerably dependent on the temperature, and it varies within a certain temperature range. According to [1], when temperature varies from 20^{0}C to 40^{0}C, the dynamic viscosity of oil reduces from 13240 MPa/sec to 2020 MPa/sec. However, the range of changes to a great extent is determined by the location of immediate oil production.

As a consequence of the above mentioned, it is possible to think of possibilities of accelerating the tanker loading with oil at the terminal, for which the oil usually undergoes heating. The heat-transfer (1) and heat balance (2) equations are as follows:

$$Q = K.\overline{\Delta t}.F \qquad (1)$$

$$Q = W_1 f_1 \rho_1 C_1 (t_1' - t_1'') = W_2 f_2 \rho_2 C_2 (t_2' - t_2'') \qquad (2)$$

where, K is a heat-transfer coefficient and it depends on the fluid viscosity, shapes of the surfaces participating in heat-exchange process and so on; F is a heat transfer area to be heated; Δt is average temperature pressure between hot and cold heat conductors;

W_1 and W_2 – speed of movement of heat conductors;

ρ_1 and ρ_2 – heat conductors viscosities;

C_1 and C_2 - thermal capacities;

f_1 and f_2 – heat conductors' streamwise sections areas;

t_1', t_2', t_1'', t_2'' - inlet and outlet temperatures of heat conductors.

During calculation of heat-exchanger, there should be taken into account the dependency of average temperature pressure ($\overline{\Delta t}$) on the motion plan and speed of heat conductors. It is noticeable that in equal conditions, the counter flow heat-exchangers are characterized by much higher heat-exchange intensity than one-sided flow apparatus. Due to this, they have relatively small sizes and take advantage from the standpoint of economy.

The paper dwells on the heating process of moving oil in the heater (pipe-in pipe) and its influence on the intensity of reloading process.

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EXPERIMENTAL STUDIES OF THE INFLUENCE OF TEMPERATURE CHANGES ON THE SPEED OF OIL MOVEMENT THROUGH PIPELINE

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The growth in demand for oil-products over the last decade set task before the scientists, which implies to extract oil without losses and its fast delivery to the consumer countries. The most spread oil type of oil overland transportation is the pipeline transport. Therefore, the proposed idea about experimental investigation of the influence of temperature changes on on the speed of oil movement through pipeline is of a highly importance and promising research.
The volume oil moving through pipeline depends on the pipe diamter and speed of oil movement:

$$Q = \omega \cdot \upsilon$$

where, ω is a pipeline cross-section, υ is average speed of oil movement.

The oil movement speed, in turn, depends on the oil temperature. Consequently, in order to determine the dependency of variation of the oil volume in pipeline on the temperature change, it is desirable to study this process in experimentally on the specially designed equipment.

For investigation of hydrodynamics of oil moving through pipeline, we have used the device, which is composed of tank filled with oil. By means of centrifugal type pump, the oil moves from the intake pipe into the longitudinal pipeline. This latter one fills in the constant-level tank, from the oil is supplied into the constant-diameter pipeline, wherein the influence of the moving mass temperature changes on the speed of oil movement and its volume is studied. On the device mounted are also: the constant-level tank; piezometers; taps; triangular culverts; damper; pipeline for returning of excessive oil into the tank; thermometer.

Over a period of time after switching-on the pump, immediately after the movement of oil assumed a stable character, we measure the temperature of oil passing through pipeline, define the volume oil by using the volumetric method, and determine the average speed of movement υ. Then we find in Tables, the kinematic coefficient of viscosity, and then we obtain the Reynolds number from the formula $R_e = \upsilon \cdot d / \nu$. The test is repeated several times for different temperatures. By using the obtained results, we construct the influence curves.

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SOME APPLICATIONS OF THE THEORY OF SHELLS WITH THE USE OF SEVERAL BASIC SURFACES

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The theory of shells with the use of several basic surfaces is based on one kinematic hypothesis. This hypothesis allows to approximately build a three-dimensional displacement field of points of the same layer (shell) of the structure in the field of basic movements of two surfaces. In the theory, the number of generalized coordinates (displacements) is exactly equal to the number of generalized forces.

The paper gives examples of mathematical models for the study of practical problems on the basis of this theory.

A ROD MODEL OF ELECTRICAL MACHINES

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Electromechanical energy conversion in the electrical machines occurs in the space, wherein the electromagnetic field energy is concentrated. The electromagnetic field is produced by currents flowing through its windings. Due to their spatiotemporal inhomogeneity the magnetic fields of the electrical machines are extremely complex. Study of magnetic field of the machine is important for understanding and analysis of its operation.

The basic idea of the proposed approach is to describe the electromechanical energy conversion occurring in the electrical machines as a result of superimposition of the electromechanical interaction of identical elements. As such elements examined are the electricity-conductive rods located along and perpendicular to the axis of machine. Using these rods with and without currents, modelled are not only all windings of the electrical machines (excitation winding, stator windings, damping windings), but circular currents of magnetic cores as well.

ON THE STABILITY OF ALL-WHEEL DRIVE VEHICLE OF AGRICULTYRAL USE WHEN DRIVING ON A SLOPE

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When using the four-wheel agricultural drive vehicle of 4x4 type, working with a trailer in mountainous areas its transmission experiencing heavy loads in the carriage of overall agricultural goods (hay, corn, cotton, etc.) there is a problem of stability against overturning. The situation is exacerbated when the vehicle is on a slope when the road is tilted across the movement.

In developing the car much attention was paid to the operation in marshy impassable places, but the question of the car moving onto a hill is not given a detailed study in the theory.

The mathematical model of the driving agricultural vehicle on a slope, with the influence of damping and stiffness of the tire in the lateral direction, as well as maneuvering the vehicle, depending on the bulk density and velocity while starting turning has been improved. These characteristics are chosen based on the results of stand tests.

ON ONE PROBLEM OF SPATIAL MOVEMENT CONTROL

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Spatial rotations are for the first time described by their spinor representation, which made it possible to obtain simple relations for their dynamic [1]. The obtained results have enabled us to reduce the actually three-dimensional problem of spatial motion control to the one-dimensional problem. A variational method is used to solve various problems of terminal control of spatial rotations. Simple and reliable adaptive algorithms are obtained, by means of which important from practice point of view a problem of the terminal control of breaking process has been solved. The models of transient processes during control process are represented. A criterion for arising of transient process was elaborated. Optimal trajectory, optimal low of dynamic of speed and acceleration which satisfy corresponding boundary conditions were determined. The detailed results of the modeling of the process of the control of the breaking process of spatial rotations are represented.

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IMAGE BASED POINT-CLOUD MODEL OF THE HAMILTONIAN DYNAMIC SYSTEM IN BIOMEDICINE

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The goal of this project is nonlinear elastic analysis of the biologic systems by the image based geometry of the actual objects.

Since elastic hysteresis of the tissue is negligibly small, Hamiltonian system successfully can be utilized for dynamic analysis of the bio-systems. Additionally, comparing to Newtonians it simplifies a procedure of numerical analysis.

Generating a high quality FE mesh for biological structures from patient-specific images remains a challenging task. FE mesh often requires a very fine mesh in regions of high gradient or geometric irregularities. Many biological structures have complicated local geometry features. For such system local mesh refinement presents an even greater challenge. Motivated by the need of eliminating FE meshing, point approximation of the geometry resolves meshing problems successfully. We recall that the meshfree method [1] constructs the approximation over local clusters of nodes that have no particular topological connection; and as a result, there is no need for mesh. The domain (i.e., solid model) is represented by a set of discrete points which we refer to as a point model. Refinement to a point model can be achieved simply by adding more nodes, either globally or locally. A distinct advantage of point model, in the context of biomedical problems, is that it connects seamlessly to image database.

We propose a new solid mechanics solver targeting image-based biomedical analysis [2]. The new method combines the salient features of the meshfree-Galerkin methods and discrete gradient methods. Symplectic operator [3] has been utilized to time integrate problem, which stabilizes and converges a numerical solution of a priori conservative Hamiltonian system.

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ON ONE METHOD OF THE STATISTICAL ESTIMATION OF PROBABILITY DISTRIBUTION BASED ON THE OBSERVATIONS OF DYNAMICS AT THE END OF THE INTERVAL

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Consider a first-order differential equation

$$y'(t) = f(t, y(t)) \quad (1)$$

given on the segment [0,T]. We study a Cauchy (initial-value) problem $y(0) = X$, where X is a random variable with unknown density of distribution $p(x)$. Assume that, for (1) this problem possesses a unique solution $y(t)$ with probability 1, which is a clearly a random process. Let us have observations $y_1(T), y_2(T), \dots y_n(T)$ at the end of the interval. It is necessary to estimate $p(x)$ according to these observations. Let

(f) $f(t,x)$ is the continuous function of its variables and has continuous derivative $f'_x(t,x)$;

(k) $K(x)$ is the continuous, positive, bounded and integrable function, such as

$$\int_R K(x)dx = 1.$$

(h) h_n is the positive sequence of real numbers converging to zero, such as $nh_n \to 0$.

Let
$$\hat{p}_T(x) = \frac{1}{nh_n}\sum_{j=1}^{n} K\left(\frac{x - y_j(T)}{h_n}\right).$$

We proved that $\hat{p}_T(x)$ is consistent estimation for $p(x)$. And the following theorem is true

Theorem. Let $\varphi_n(x)$ be the sequence uniformly converging to the solution of differential equation (1) with initial condition, where X is a random variable with unknown density of distributions $p(x)$ and the conditions (f), (k) and (h) are met. Then the consistent estimation of the density $p(x)$ is given by formula

$$\hat{p}(x) = \frac{\partial(\varphi_n(T))}{\partial x}\hat{p}_T(\varphi_n(T)).$$

VISCOELASTIC ROD VIBRATION PROBLEM WHEN CONSTITUTIVE RELATION CONTAINS A FRACTIONAL DERIVATIVE

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Consider the problem of the oscillations of the infinite viscoelastic rod, when the constitutive relation between stress and strain is given in the form

$$\sigma(t,x) = E\eta^{\beta} D^{\beta} \varepsilon(t,x), \quad 0 < \beta < 1,$$

where D^{β} denotes the fractional derivative in the Riemann-Liouville sense. In the beginning consider the problem when the external load depends only on the spatial coordinates. The solution to this problem in the general case is found. It is shown that the critical values of β i.e., when $\beta = 0$ and $\beta = 1$ obtained solution coincides with the classical solutions of hyperbolic and parabolic equations. The case is also considered when the external load depends on time in a periodic manner.

A PROBLEM OF THE PLANE THEORY OF ELASTICITY FOR A DOMAIN WITH A PARTIALY UNKNOWN BOUNDARY

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The problem of the plane theory of elasticity for a homogeneous isotropic plate, which is in the complex plane is simply connected domain whose boundary consists of a convex polygonal and smooth line. We look for the outline shape, provided that it tangential normal stress is constant. It is shown that the equations of the unknown circuit can be obtained from well-known formulas for the Schwarz-Christoffel conformal mapping of a polygon on a half-plane.

moqnili Reroebis arawrfivi rxevebi impulsuri datvirTvis dros

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Rerovani sistemebi, romlebic urTierTqmedeben haeris an siTxis nakadTan farTod gamoiyeneba teqnikis sxvadasxva dargSi. nakadis zemoqmedebis Sedegad Reros forma mniSvnelovnad icvleba da masze moqmedi Zalebi damokidebuli arian Reros formaze. informacia aseTi Zalebis Sesaxeb mcirea, rac garkveul sirTuleebs qmnis aseTi konstruqciebis gaangariSebis dros.

xSir SemTxvevaSi Rerovani konstruqciebis (bagirebi, eleqtrogadamcemi xazebi, Slangebi) gaangariSebis dros SesaZlebelia ugulebelvyoT maTi sixiste grexasa da Runvaze da ganvixiloT rogorc absoluturad moqnili Rero (Zafi).

warmodgenil naSromSi ganxilulia Slangebis arawrfivi rxevebi, rodesac masSi miedineba stacionaluri siTxis nakadi. Tu nakadis siCqare nulis tolia, maSin, rogorc kerZo SemTxvevas, miviRebT bagirebis, eleqtrogadamcemi xazebis da sxvaTa moZraobis gantolebebs.

Slangze moqmedi aerodinamikuri nakadiT gamowveuli ganawilebuli Zalebis intensivoba SeiZleba warmovadginoT ori Sesakrebis saxiT;

$$\vec{q}_a = \vec{q}_{a,0} + \vec{q}_{a,d} \,.$$

sadac, $\vec{q}_{a,0}$- stacionaluri nakadiT gamowveuli aerodinanikuri Zalis intensivobaa, xolo $q_{a,d}$ -am nakadis dinamikuri mdgenelia. Slangis moZraobis diferencialur gantolebebs uganzomilebo parametrebSi aqvs saxe:

$$\vec{L}_1 = \frac{\partial^2 \vec{u}}{\partial \tau^2} + 2nw_0 \frac{\partial^2 \vec{u}}{\partial \varepsilon \partial \tau} + \alpha \frac{\partial \vec{u}}{\partial \tau} - \frac{\partial \vec{Q}_{1,d}}{\partial \varepsilon} + \vec{q}_{a,d} = 0, \qquad (1)$$

$$\dot{\vec{u}} - (\vec{e}_1 \vec{u}) - \frac{1}{Q_{10}}(\vec{Q}_{1,d}\vec{e}_1) - \frac{\vec{Q}_{1,d}}{Q_{10}} = 0. \qquad (2)$$

am gantolebebis moxsnisaTvis jer vpoulobT amonaxsens im SemTxvevaSi, rodesac Siga nakadis siCqare da aerodinamikuri Zalebis intensivoba nulis tolia. miRebuli amonaxsnebi warmoadgenen rxevis formebs. vsargeblobT SesaZlo gadaadgilebaTa principiT. (1), (2) gantolebebis amonaxsens veZebT, rogorc rxevis formebis wrfiv kombinacias. Sesabamisi gardaqmnebis Semdeg davdivarT Cveulebriv diferencialur gantolebaTa sistemaze. vpoulobT am sistemis amonaxsnebs mocemul sawyis pirobebSi. es amonaxsnebi saSualebas gvaZlevs ganvsazRvroT Slangis geometriuli forma da daWimuloba, romelTa codna aucilebelia konstruqciis simtkiceze gaangariSebisaTvis. amonaxsnis analizidan SeiZleba davaskvnaT, rom impulsuri aerodinamikuri datvirTvebi mniSvnelovnad zrdis Slangis daWimulobas da gadaadgilebas. am Sedegis gaTvaliswineba saSualebas mogvcems avamaRloT konstruqciis saimedooba.

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Termodrekadobis Teoriis neimanis Siga da gare amocanebis amoxsna sferosaTvis mikrotemperaturis gaTvaliswinebiT

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naSromis mizania Termodrekadobis wrfivi Teoriis neimanis Siga da gare amocanebis cxadi saxiT amoxsna sferosaTvis mikrotemperaturis gaTvaliswinebiT. amonaxsnebi warmodgenili iqneba absoluturad da Tanabrad krebadi mwkrivebis saxiT.

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statikuri Zelis arawrfivi gantolebis amoxsnis iteraciuli meTodi

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$$u''''(x)-m\left(\int_0^l u'^2(x)dx\right)u''(x)=f(x),\quad 0<x<l, \qquad (1)$$

pirobebiT

$$u(0)=u(l)=0,\qquad u''(0)=u''(l)=0. \qquad (2)$$

aq $m(z)\geq\alpha>0$, $0\leq z<\infty$ da $f(x)$, $0<x<l$, aris mocemuli funqciebi, $u(x)$, $0\leq x\leq l$, gansasazRvreli funqciaa, xolo l da α – mocemuli mudmivebi.

(1) aris stacionaruli problema, romelic ukavSirdeba voinovski-krigeris mier SeTavazebul dinamiuri Zelis Runvis models.

grinis funqciis gamoyenebiT (1), (2) amocana daiyvaneba arawrfiv integralur gantolebaze

$$u(x)=\int_0^l G(x,\xi)f(\xi)\,d\xi+\frac{1}{\tau}\varphi(x), \qquad (3)$$

sadac

$$G(x,\xi)=\frac{1}{\tau\sqrt{\tau}\,\sinh(\sqrt{\tau}l)}\begin{cases}\sinh\left(\sqrt{\tau}(x-l)\right)\sinh\left(\sqrt{\tau}\xi\right), & 0<\xi<x<l,\\ \sinh\left(\sqrt{\tau}(\xi-l)\right)\sinh\left(\sqrt{\tau}x\right), & 0<x<\xi<l,\end{cases}$$

$$\tau=m\left(\int_0^l u'^2(x)\,dx\right),$$

$$\varphi(x)=\frac{1}{l}\left((l-x)\int_0^x \xi f(\xi)\,d\xi+x\int_x^l (l-\xi)f(\xi)\,d\xi\right).$$

gantoleba (3) ixsneba iteraciuli meTodiT. Seswavlilia am meTodis sizustis sakiTxi.

Mmyari deformadi garemos meqanikis ganviTarebis zogierTi fragmentis Sesaxeb

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მოხსენებაში, რომელიც მიმოხილვითი ხასიათისაა და შეეხება თითქმის ნახევარსაუკნოვან პერიოდს, განხილულ იქნება მყარი დეფორმადი სხეულების არაწრფივი მექანიკის მათემატიკური პრობლემები. გადმოცემული იქნება იზოტ-როპული ერთგვაროვანი სხეულების შემთხვევაში დრეკა-დობის წრფივი თეორიის ზოგიერთი კლასიკური შედეგების განვრცობისა და დაფუძნების და ანიზოტროპული არაერთ-გვაროვანი ცვლადი სისქის, არამარტო დრეკადი, გარემოს თერმოდინამიკის ამოცანების რიცხვითი რეალიზაციის საკითხები. მოხსენების ნაწილი გადმოცემულ იქნება [1]–ის გვ. 195-240–ის მიხედვით.

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ერovnuli

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anizotropuli prizmuli sxeulis daZabul-deformirebuli mdgomareobis gansazRvra ganivi Zalis Runvis SemTxvevaSi

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naSromSi Seswavlilia marTkuTxa kveTis mqone anizotropuli prizmuli sxeulis daZabul-deformirebuli mdgomareobis amocana ganivi ZaliT Runvis SemTxvevaSi. hipoTezuri daSvebebis (maT Soris sen-venanis principis) gamoyenebis gareSe mocemulia dasmuli amocanis zusti amoxsna uwyvet tanTa zogad mecnierebaSi i. RuduSauris mier Seqmnili axali Teoriis gamoyenebiT. moZebnilia Sinagani Zabvisa da gadaadgilebis komponentebi, romlebic akmayofileben amocanis Sesabamis sasazRvro da sawyis pirobebs, wonasworobis gantolebebs da fizikur gantolebebs.

mTis qanebi mewyer-Camonaqcevi masis dacurebis zedapirebis analizuri aRwera

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xSiria mTis qanebis ferdoebis an masze Tovlis safaris statikuri da dinamikuri mdgradobis dakargvis SemTxvevebi, rac iwvevs ferdoebis mewyer-Camonaqcevebis da Tovlis zvavebis Camosvlas.
xelovnuri da bunebrivi ferdoebis statikuri da dinamikuri mdgradobisa da zvavebis warmoSobiT miyenebuli zarali ZiriTadad gamowveulia nagebobebis arasakmarisi saimedoobiT, dacvis uunarobiT da maTi ganlagebis ara optimaluri SerCeviT.
mkvlevarTa umravlesoba miiCnevs, rom ferdoebis CamoSvavebuli masis saSiSi dacurebis zedapiri warmoadgens wriul-cilindruls (brtyeli amocanis SemTxvevaSi _ wris rkals), rac globalurad naklebadaa mosalodneli da igi WeSmariti saSiSi dacurebis zedapiris mxolod uxeSi miaxloebaa.
ganvixilavT mTis qanebis ferdoebis mdgradoba-aramdgradobis amocanebs, sadac pirveladaa mocemuli, arsebuli bunebrivi pirobebis maqsimaluri gaTvaliswinebiT, ferdoebis masivebis Camonaqcevis saxifaTo dacurebis mrudwiruli zedapiris gansazRvris amocanis sufTa analitikuri amoxsna.
gamoyvanilia movlenis aRmweri Cveulebrivi da kerZo warmoebulebiani diferencialuri gantolebebi, romelTac akmayofilebs mTis fxvieri qanebis ferdoebis Camonaqcevi masis saSiSi dacurebis zedapiris amsaxveli zRvruli wonasworobis mrudis gantoleba (brtyeli amocanis SemTxveva) da sibrtyis gantoleba (sivrciTi SemTxveva). kvadraturebSia amowerili am mrudis gantoleba. arawrfivi kerZo-

warmoebulebiani gantolebis amosaxsnelad dadgenilia sawyisi pirobebi, aigebulia zogadi da kerZo amonaxsnebi.

mTis qanebis mewyeruli masivi warodgenilia, rogorc kvazimkvrivi tani, romlis daZvrisa da dacurebis pirobebi parametrulad ganisazRvreba fxvieri tanebis iseTi meqanikuri parametrebiT, rogoricaa Sinagani xaxunis kuTxe, moculobiTi wona da SeWiduloba, agreTve daZvris sibrtyisa da mTavar daZabulobebs Soris urTierT mimarTebis Tvisebebis zRvrul wonasworobis pirobebi. miRebulia SeWidulobis koeficientis kerZo SemTxvevebis da zogadi mniSvnelobebisaTvis dacurebis wiris gantoleba da gamokvleulia integraluri wirebis asimptoturi Tvisebebis yvela SesaZlo SemTxvevisaTvis. G

naSromis mizania damuSavebul iqnes ferdoebis mdgradobis gaangariSebis axali srulyofili proeqtirebaSi martivad gamoyenebadi meTodebi, romlebic dafuZnebulia ferdos daZabul-deformirebuli mdgomareobis gansazRvraze, gruntis ama Tu im maTematikuri modelis gamoyenebaze yvela moqmedi Zalis mkacri gaTvaliswinebiT, gruntis Tvisebebis maCvenebelTa cvalebadobis gaTvaliswineba da agreTve dacurebis savaraudo zedapirebis formisa da mdebareobis povniT.

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Msakonstruqcio masalis mdgradoba drekadobis farglebs gareT

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myari deformirebadi sxeulis meqanikis erT-erT mniSvnelovan sakiTxs warmoadgensmasalis aradrekadi deformaciebis aRwera. Termodinamikis SesaZleblobebi am SemTxvevaSi SezRudulia umTavresad imitom, rom rTulia Sinagani mdgomareobis parametrebis SerCeva. Aamitom saWiro xdeba damatebiTi daSvebebis SemoReba.

imisaTvis, rom aradrekadi deformaciebi avRweroT calsaxad da arawinaaRmdegobrivad Cveulebriv SemoaqvT damatebiTi postulatebi, romlebic faqtobrivad warmoadgenen gaazrebul SezRudvebs. aseTia masalis mdgradobis postulati. Mmasalis mdgradobis postulatis SemoReba iZleva im fundamentaluri pirobebis miRebis saSualebas, romelTa Sesrulebac gvaZlevs praqtikulad mniSvnelovan Tanafardobebs.

sakonstruqcio masalebis aradrekadi deformaciebis aRwerisaTvis gamoiyeneba drukeris mier SemoRebuli mdgradobis postulati [1] da iliuSinis plastikurobis postulati [2]. Ees postulatebi formulirebulia izoTermuli deformirebis procesebisaTvis.

drukeris postulatis Tanaxmad, damatebiTi Zabvebis muSaoba nebismieri Caketili Zabvebis mimarT mrudis gaswvriv dadebiTia Tu xdeba plastikuri deformaciebis cvlileba da tolia nulis pasiuri deformaciebisas.

$$\oint_{\gamma}(\sigma_{ij}-\sigma_{ij}^{0})d\varepsilon_{ij}\geq 0 \qquad (1)$$

sadac: $\sigma_{ij},\sigma_{ij}^{0}$- namdvi l i da dasaSvebi Zabvebis komponentebia Sesabamisad.

i l iuSinis p l astikurobis postu l atis Tanaxmad Zabvis muSaoba nebismier, deformaciebis sivrceSi Caketi l mrudze, nu l is to l ia Tu p l astikuri deformacia mTe l traeqtoriaze rCeba ucv l e l i da dadebiTia, Tu Caketi l i mrudis rome l ime ubanze (ubnebze) mainc xdeba p l astikuri deformaciebis cv l i l eba.

$$\oint_{\varepsilon} \sigma_{ij} d\varepsilon_{ij} \geq 0 \qquad (2)$$

Aaq σ_{ij} - mT l iani Zabvebia.

Mmasa l is motani l i mdgradobis postu l atebi arsebiTad warmoadgenen eqsperimenta l urad dadgeni l i faqtebis ganzogadebas. Eeqsperimenta l uri monacemebis ganzogadebas warmoadgens aseve sakonstruqcio masa l ebis mdgradobis piroba Termomeqanikuri datvirTvisas Caketi l i mrudis gaswvriv Zabvebisa da temperaturis sivrceSi "datvirTva-gantvirTva-gaciveba-gaxureba" integra l i arauaryofiTia:^

$$\oint (\sigma_{ij} - \sigma_{ij}^{0}) d\varepsilon_{ij} + a_{ij}(\varepsilon_{ij} - \varepsilon_{ij}^{0}) dT \geq 0 \text{ @@} \qquad (3)$$

aq ε_{ij}- namdvi l i, σ_{ij} Zabvebis Sesabamisi deformaciebia, ε_{ij}^{0}- rome l iRac dasaSvebi, σ_{ij}^{0} Zabvebis Sesabamisi deformaciebia, a_{ij} tenzori SemoRebu l ia ganzomi l ebebis gasaTanabreb l ad.

ori sxvadasxva ganzomi l ebis mqone p l ankisa da furies uto l obebis gaerTianeba miRebu l ia uwyveti aris TermodinamikaSi. Sedegad miiReba k l auzius-diugemis uto l oba, rome l ic warmoadgens Termodinamikur aqsiomas.

zemoTmotani l pirobebs mivyavarT sxvadasxva eqstrema l ur principebamde, rome l Ta safuZve l zec miiReba ganmsazRvre l i ganto l ebebi. (1) pirobidan

gamomdinareobs datvirTvis zedapiris amozneqi l oba da gradientu l i dineba. (3) piroba iZ l eva saSua l ebas avRweroT datvirTvis zedapiris ca l keu l i ubnebis Cazneqi l oba da dinebis aragradientu l i xasiaTi.

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i. vekuas meTodis gamoyeneba geometriulad arawrfivi aradamreci sferuli garsebisaTvis

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mocemul naSromSi ganxilulia geometriulad arawrfivi aradamreci sferuli garsebi. i. vekuas meTodiT miRebulia organzomilebian gantolebaTa sruli sistema [1, 2]. kompleqsuri cvladis funqciebisa da mcire parametris meTodis gamoyenebiT agebulia miaxloebiTi amonaxsni $N=1$ miaxloebisTvis. amoxsnilia konkretuli amocanebi.

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Termodrekadobis zogierTi amocanis dasma da amoxsna sqeli filisaTvis

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warmodgenil moxsenebaSi dasmulia da analizurad amoxsnilia Termodrekadobis Semdegi amocanebi.

ganixileba sqeli filis drekadi wonasworoba dekartis marTkuTxa koordinatTa sistemaSi. sqeli fila transtropulia da erTgvarovania. Ffilis gverdiT waxnagebze mocemulia simetriis an antisimetriis pirobebi. zeda da qveda waxnagebze mocemul SeSfoTebebSi igulisxmeba. rom mocemulia Zabvebi da temperatura, an gadaadgilebebi da temperatura. temperaturis nacvlad SeiZleba iyos mocemuli misi normaluri warmoebuli.

amocana amoxsnilia analizurad, sadac gadaadgilebebi warmodgenilia usasrulo mwkrivebis saxiT. am mwkrivis yoveli wevri warmoadgens eqsponencialuri da trigonometriuli funqciebis namravls.

madloba. winamdebare naSromi Sesrulebuli iyo saqarTvelos teqnikur universitetSi.

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Txeli xisti CarTvis mqone marTkuTxovani firfitis Runvis amocanis miaxloebiTi amoxsnis erTi meTodis Sesaxeb

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naSromebSi [1,2] Txeli xisti CarTvis mqone marTkuTxovani firfitis Runvis amocanebi miyvanilia gluvi gulis mqone pirveli gvaris integralur gantolebaze. Aam gantolebis amonaxsni moiZebneba araintegradi gansakuTrebulobis mqone funqciaTa klasSi. Nnaxtomebis funqcias SeiZleba hqondes araintegrebadi gansakuTrebuloba Semdegi saxis Nnaxtomebis $\Psi(x)$ funqcias SeiZleba hqondes Semdegi saxis araintegrebadi gansakuTrebuloba

$$\Psi(x)=(x-c_1)^{-3/2}(c_2-x)^{-3/2}\Psi_0(x).$$

naSromebSi [1,2] miRebuli integraluri gantoleba amoxsnilia speqtraluri (orTogonaluri mravalwevrebis) meTodiT, kerZod, gamoyenebulia iakobis orTogonaluri polinomebi.

warmodgenil naSromSi SemoTavazebulia zemoaRniSnuli integraluri gantolebis miaxloebiTi amoxsnis axali algoriTmebi kolokaciis meTodis gamoyenebiT. kerZod naSromSi gamoyenebulia diskretul gansakuTrebulobaTa meTodi [3] Tanabrad daSorebuli kvanZebis SemTxvevaSi. GCven iseve rogorc [1,2]-Si vuSvebT rom firfitis sazRvari saxsrovnad dayrdnobilia.

ricxviTi gaTvlebis saSualebiT gamokvleulia firfitis CaRunvis funqciis mniSvnelobebze CarTvis sigrZisa da masis gavlena.

madloba. winamdebare naSromi Sesrulebuli iyo SoTa rusTavelis erovnuli samecniero fondis xelSewyobiT (Grant AR/320/5-109/12).

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wamaxvilebuli formis brtyeli figurebis gaangariSebis Sesaxeb myari drekadi sxeulebis diskretuli Rerovani struqturebiT warmodgenis saSualebiT

დავით პატარაია
გ. წულუკიძის სამთო ინსტიტუტი

მოხსენება ეხება წამახვილებული ფორმის ბრტყელი სხეულების მოდელირებასა და გაანგარიშებას მყარი დეფორმირებადი სხეულების დისკრეტული ღეროვანი სტრუქტურების კომბინაციებით წარმოდგენის საშუალებით.

madloba. წინამდებარე ნაშრომი შესრულებული იყო შოთა რუსთაველის ეროვნული სამეცნიერო ფონდის გრანტის # 30/28 ფარგლებში.

naxevarsibrtyeSi drekad narevTa statikis zogierTi sasazRvro amocanis efeqturad amoxsnis Sesaxeb

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ნაშრომში ნაჩვენებია, რომ დრეკად ნარევთა წრფივი თეორიის სტატიკის ზოგიერთი სასაზღვრო ამოცანის ეფექტურად ამოხსნა ნახევარსიბრტყეში შეიძლება მიყვანილ იქნას ამავე არეში დირიხლეს ამოცანაზე, ლაპლასისა და პუასონის განტოლებებისათვის, ხოლო ნეიმანის ამოცანაზე პუასონის განტოლებისათვის.

Termodrekadobis klasikuri da araklasikuri sasazRvro-sakontaqto amocanebis analizuri amoxsna kumSvadi da ukumSi fenebisagan Sedgenili cilindruli sxeulebisaTvis

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naSromi exeba Termodrekadobis zogierTi gamoyenebiTi xasiaTis amocanis analizuri amonaxsnis agebas mravalfeniani cilindruli sxeulebisaTvis. masTan zogierTi fena SeiZleba warmoadgendes ukumS Termodrekad masalas. Ggansaxilveli amocanebisTvis miRebulia analizuri amonaxsnebi da maT safuZvelze Sedgenilia Sesabamisi programa.

wriuli cilindruli koordinatTa sistemis sakoordinato zedapirebiT SemosazRvruli, radialuri koordinatis mimarT N-feniani cilindruli sxeulebisaTvis ganixileba statikuri Termodrekadi wonasworoba. cilindruli sxeulis brtyel sazRvrebze dasmulia amonaxsnis simetriuli an antisimetriuli uwyveti gagrZelebis sasazRvro pirobebi, xolo cilindrul sasazRvro zedapirebze nebismieri sasazRvro pirobebia mocemuli. Ffenebs Soris SeiZleba mocemuli iyos xisti, sriala, an sxva tipis sakontaqto pirobebi. Ddasmuli amocanebis amoxsna xorcieldeba analizurad, cvladTa gancalebis meTodiT. amasTan moiyeneba amonaxsnis zogadi warmodgena harmoniuli funqciebis saSualebiT. mocanebis amoxsna daiyvaneba blokur-diagonaluri matricis mqone wrfiv algebrul gantolebaTa sistemebis amoxsnaze.

madloba. winamdebare naSromi Sesrulebuli iyo gamoyenebiTi kvlevebisaTvis saxelmwifo samecniero grantis AR/91/5-109/11 (SeTanxmeba N 10/17) farglebSi.

ჰიდროაერომექანიკა

wonasworuli garemodan energiis generaciis SesaZleblobis Sesaxeb

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naSromSi gamaxvilebulia yuradReba im faqtze, rom informaciebs wonasworuli sivrcidan (kerZod, vakuumidan) energiis miRebis Sesaxeb, aqvs myari Teoriuli dasabuTeba da msgavsi movlenebi SeuZlebelia aixsnas klasikuri, wonasworuli Termodinamikis safuZvelze, vinaidan igi ar iTvaliswinebs nivTierebis rTul struqturas, mis unars, awarmoos gardaqmnebi da moaxdinos energiis Siga cirkulacia (akumulacia da gamonTavisufleba).

AaRniSnul movlenebs SeuZliaT gamoiwvion Tboizolirebuli sistemis moCvenebiTi gaTboba an gacieba, anu entropiis iseTi Semcireba, rac ar eqvemdebareba meore kanonis moTxovnebs. Pavtoris mier, pirvelad moxda klasificireba iseTi araordinaruli procesebisa, romlebic SeiZleba aRiniSnon Saubergeris terminiT – implozia.

samyaros diskretuli, qaoturi struqturis TvalsazrisiT, nebismieri sxeuli an sistema imyofeba arawonasworul, an pirobiTad wonasworul mdgomareobaSi. Sesabamisad, wonasworuli, fenomenologiuri Termodinamika da karnos Teoria samarTliani arian iseTi pirobiTi sistemebisaTvis, romlebic, realurad, bunebaSi ar arseboben. Ees ki, rig SemTxvevebSi, iwvevs kanonTa konfliktS.

magaliTad, meore kanonis Sesabamisad, Tu fizikuri sxeulebis sistemaSi, gansazRvruli temperaturis pirobebSi, mimdinareobs endoTermiuli qimiuri reaqcia, maSin sapirispiro reaqcia, siTbos gamoyofiT, usaTuod unda warimarTos igive an ufro dabali temperaturis pirobebSi. amasTan, aseTi principis mkacri empiriuli an sxvagvari dasabuTeba ar arsebobs da arc SeiZleba arsebobdes, vinaidan realurad, dafiqsirebulia sawinaaRmdego efeqti.

Aavtoris mier, mis naSromebSi [1,2] naCvenebia, rom, Tu Termodinamikur ciklSi, gansazRvruli temperaturis dro, xorcieldeba implozia (magaliTad, siTbos STanTqmis endoTermuli qimiuri reaqcia, turbulentobis an kavitaciis warmoSoba da sxva), xolo sapirispiro procesi siTbos gamoyofiT (disipacia) mimdinareobs ufro maRali temperaturis pirobebSi, maSin cikls SeuZlia moaxdinos sasargeblo energiis uwyveti generacia garemomcvelis sivrcis gaciebis xarjze.

magaliTad, msgavsi efeqti SeiZleba dafiqsirdes wylis daSlis da sinTezis procesebis monacvleobis gziT. naCvenebia rom, wyali, amgvarad (kerZod, kavitaciis procesSi) xdeba sasargeblo energiis wyaro an misgan miiReba sawvavi. amasTan, sinamdvileSi, wylis daSlisaTvis saWiro siTbo aerTmeva garemos, an es xdeba sxva saxis energiis (magaliTad vakuumis energiis) xarjze.

sainteresoa, rom, ukanasknel wlebSi intensiurad qveyndeba informaciebi msgavsi teqnologiebiT wyalbadis da brounis gazis miRebis Sesaxeb energiis mcire, sastarto danaxarjiT.

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sanapiro zolSi liTodinamikuri procesebis modelireba

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bunebrivma movlenebma rogoricaa: qari, talRa, qariSxali, cunami, da zRvis donis mateba - SesaZloa gamoiwvios plaJis (sanapiros) topografiis cvlileba napiris uaxloes zonebTan. Tumca, cvlileba aseve SeiZleba gamowveuli iqnes adamianis CarevebiTa da saqmianobiT, magaliTad, rogoricaa - talRamWrelebi, molebi, wyalsawinaaRmdego dambebi, miwis xelsawyoebi, da sanapiros kveba. maSasadame, am zonaSi sanapiros topografiis evoluciis gageba saWiro da mniSvnelovania sanapiros iseTi sainJinro proeqtebisTvis, magaliTad, rogoricaa – navsadgurebis mSenebloba, sanavigacio arxebis SenaxvaSenarCuneba, sanapiros dacva eroziisgan. Ukanasknel aTwledis ganmavlobaSi, sanapiros morfologiuri evoluciis modelirebisaTvis Tanamedrove ricxviTi modelebi iqna gamoyenebuli. Mmravali aseTi ricxviTi modeli ganaviTares da gamoiyenes bevr praqtikul SemTxvevebSi. Tumca, hidrodinamikuli da morfologiuri procesebi sanapiros uaxloes zonebSi uaRresad rTulia da Cven codnas aRemateba misi detaluri aRwera. amgvarad, es ricxviTi modelebi xSirad Seicaven procesebis SezRudul raodenobas, rac icvleba droisa da sivrcis mixedviT. ufro metic, maRalxarisxiani da sinqronizebuli monacemebi laboratoriebidan aseve SezRudulia, rac arTulebs modelis Sefasebas.

Cveni kvlevis mTavari mizani iyo: sanapiros topografiis evoluciis sando ricxviTi modelis Seqmna talRebTan da dinebebTan mimarTebaSi, sadac aseve mTavari aqcenti gakeTdeboda sanapiros struqturis zemoqmedebaze. aseTi modeli aRwers rogorc talRis grZiv, iseve talRis ganiv arsebul sedimenturi transportis efeqtebs, rac icvleba sezonurad. am miznis gamartivebisTvis ganviTarda da gaumjobesda mravali qve-modeli, maT Soris

1. SemTxveviTi talRis transformaciis modeli; 2. zedapirze mgoravi efeqti; 3. sanapiros zolSi talRis dinebis modeli; 4. natanis modeli; 5. Mmorfologiuri evoluciis modeli.

ricxviTi modelebidan miRebuli Sedegebi iyo damakmayofilebeli da kargad eTanxmeoboda zomebs. simulaciebma gviCvena, rom talRis gamoTvlis pirobebi da talRis sigrZivi dineba kargad iyo warmoebuli. gamoTvlili talRis gaswvrivi dineba odnav naklebi iyo zomebze. Tumca, is karg SesabamisobaSi iyo struqturasTan. amis miusedavad, didi gansxvaveba ar iyo gamoTvlebsa da zomebs Soris. sanapiros morfologiuri evolucia talRebsa da dinebebs qvemoT, talraTmWrelebisa da molebis axlos kargad eTanxmeba zomebs. rogorc amozneqili, ise tomboluri warmoqmna am struqturebs miRma kargad iqna warmodgenili ricxviTi modelis mier. momavalSi, es modeli ufro kargad Sefasdeba laboratoriis monacemTa sapasuxod.

es modeli gamoyenebuli iqneba sanapiros proeqtebSi raTa viwinaswarmetyveloT sanapiros evolucia sanapiro struqturebis siaxloves.

bunebrivi gazis milsadenebSi dinebis maTematikuri modelireba hidratebis formirebis gaTvaliswinebiT

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amJamad milsadenebi warmoadgenen bunebrivi gazis transportirebis erT-erT yvelaze xelsayrel saSualebas. milsadenis CaWedvis (avariuli Caketvis) ZiriTadi mizezebia: hidratebis warmoSoba, wylis sacobebis gayinva, danagvianeba da sxva. imisaTvis, rom droulad iqnes miRebuli zomebi hidratebis warmoqmnis sawinaaRmdegod (vinaidan mosalodnelia gaJonvac), saWiroa Seswavlili iqnes milsadenSi tenianobis, wnevisa da temperaturis ganawileba. cnobilia, rom hidratis warmoqmnis xelSemwyobi pirobebi warmoiqmneba magistralis gaswvriv iq, sadac namis wertili (temperaturis is mniSvneloba, romlis Semcirebis pirobebSi iwyeba gazSi arsebuli wylis orTqlis kondensacia) warmoiqmneba. rogorc cnobilia namis wertili SesaZlebelia gamovTvaloT hidratis warmoqmnis wonasworuli temperaturis grafikisa da gazis temperaturis Sesabamisi mrudis gadakveTis saSualebiTac. warmodgenil naSromSi bunebrivi gazis milsadenSi arastacionaruli dinebis SemTxvevaSi Seiswavleba hidratebis warmoqmnis SesaZlo adgilmdebareobis gansazRvris axali meTodi, romelic iyenebs namis wertilis gansazRvrasac. gazis arastacionaruli dinebis SemTxvevaSi SemoTavazebuli meTodi eyrdnoba hidroTermodinamikis kerZo warmoebulian diferencialur gantolebaTa sistemis integrirebas. Warmodgenilia ricxviTi Tvlis zogierTi Sedegebi. miRebulma Sedegebma aCvena SemoTavazebuli meTodis efeqturoba, vinaidan isini karg TanxvedraSia preqtikuli saqmianobidan cnobil dakvirvebul masalebTan.

madloba. winamdebare naSromi Sesrulebuli iyo SoTa rusTavelis erovnuli samecniero fondis grantis #GNSF/ST09-614/5-21 farglebSi.

Savi zRvis zeda fenis Termuli reJimis sezonuri Taviseburebebis ricxviTi gamokvleva

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zRvisa da okeanis turbulenturi Serevis fenis Termuli reJimis Taviseburebа ara mxolod gansazRvravs zRvisa da atmosferos urTierT zemoqmedebis xarisxs da klimatis formirebas, aramed igi mniSvnelovan zemoqmedebas axdens zRvis cocxali organizmebis ganviTarebaze. igive unda iTqvas Savi zRvis turbulenturi Serevis fenazec.

kvlevis mizania Sefasdes siTbos gadatanis Taviseburebа horizontze Savi zRvis turbulenturi-Serevis fenaSi. aseve ganisazRvros fenis sisqe da misi cvalebadoba zRvis zedapirze ganviTarebuli atmosferuli procesebis cvalebadobis Sesabamisad.

Savi zRvis dinamikis 3-ganzomilebiani ricxviTi modelis (a. kordZaZisa da d. demetraSvilis) gamoyenebiT Catarebulia ricxviTi eqsperimentebi. analizma aCvena, rom temperaturuli velis ganawileba horizontze Savi zRvis Serevis turbulentur fenaSi dakavSirebulia Termohalinuri zemoqmedebis cvalebadobaze, xolo fenis sisqes gansazRvravs atmosferuli cirkulaciuri procesebi. magaliTad, civ sezonSi Zlieri qaris dros turbulenturi Serevis fenis sisqe aRwevs maqimums (16m). Tbil sezonSi, aprilidan agvistos bolomde ki, SeimCneva turbulenturi Serevis fenis SeTxeleba.

განზოგადოებული ინტეგრალური განტოლებები სასაზღვრო შრისათვის

რევაზ ქავთარაძე
მოსკოვის ნ. ე. ბაუმანის სახელობის ტექნიკური უნივერსიტეტი,
მოსკოვი, რუსეთის ფედერაცია

მიღებულია განზოგადოებული ინტეგრალური განტოლებები ტურბულენტური სასაზღვრო შრისათვის, რომელიც წარმოიშვება მრუდი ზედაპირის გარსშემოდინებისას გაზით, როცა ეს გაზი ასხივებს და შთანთქავს თბურ ენერგიას. ნაჩვენებია, რომ კარმანისა და პოლჰაუზენ-კრუჟილინის ცნობილი ინტეგრალური პირობები მიღებული განტოლებების კერძო შეთხვევას წარმოადგენენ. მიღებული განტოლებები გამოიყენება რთული (რადიაციულ-კონვექციური თბოგადაცემის საკვლევად).

or forovan cilindrs Soris siTxis dinebaSi gadasvlebis Sesaxeb radianuli da QRerZuli wnevis gradientis moqmedebisas

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Seswavlilia or forovan cilindrs Soris blanti ukumSi siTxis dinebis mdgradobis amocana radianuli da RerZuli wnevis gradientis moqmedebisas. msgavsi dinebebi ganixileba teqnikur hidrodinamikaSi filtraciis amocanebis Seswavlisas.

ZiriTadi stacionaruli dinebis mdgradobis dakargva SesaZlebelia moxdes rogorc RerZsimetriuli, ise araRerZsimetriuli SeSfoTebebis Sedegad. pirvel SemTxvevaSi xdeba stacionaruli dinebis gadasvla meorad RerZsimetriul dinebaSi griglebis saxiT, xolo araRerZsimetriuli SeSfoTebebis Sedegad stacionarul dinebas cvlis drois mimarT perioduli dinebebi azimuturi talRebiT.

moxsenebaSi warmodgenili iqneba gadasvlebi im rTuli reJimebisaken, romlebic SeiZleba warmoiqmnan im neitraluri wirebis gadakveTis wertilis mcire midamoSi, romlebic Seesabamebian zemoT aRniSnul aramdgradobebs.

didmasStabiani zonaluri dinebebisa da magnituri velebis generacia mcire masStabiani turbulentobiT ionosferoSi

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Seswavlilia mcire masStabiani (skin sisqis $k_{\perp}^2 c^2 / \omega_{pe}^2 \sim 1$) dreifuli alfenis turbulentobiT ganpirobebuli didmasStabiani zonaluri dinebebisa da magnituri velebis arawrfivi generaciis Taviseburebebi ionosferul plazmur garemoSi. miRebulia wanacvlebiTi dinebebisa da magnituri velis evoluciis gantolebebi Cqari maRalsixSiruli da mcire masStabiani fluqtuaciebis aRmweri modeluri gantolebebis saSualebiT. naCvenebia, rom mcire masStabiani dreifuli alfenis turbulentobiT spontanurad generirdebian didmasStabiani zonaluri dinebebi da magnituri velebi, rac ganpirobebulia reinoldsisa da maqsvelis Zabvis arawrfivi urTierTqmedebiT garemos nawilakze. sistemaSi Cndeba dadebiTi ukukavSiri didmasStabiani zonaluri da/an magnituri velis mier mcire masStabiani skin sisqis alfenis talRebis modulaciiT. mcire masStabiani talRuri paketis gavrcelebas garemoSi Tan axlavs parametruli aramdgradobiT ganpirobebuli dabalsixSiruli didmasStabiani SeSfoTebebi. Seswavlilia aramdgradobis ori reJimi: rezonansul-kinetikuri da hidrodinamikuri. napovnia am aramdgradobebis inkrementebi. gansazRvrulia aramdgradobis ganviTarebisa da didmasStabiani struqturebis gaCenis pirobebi. aRniSnuli aramdgradobebi iwveven energiis gadaqaCvas mcire masStabiani alfenis talRebidan didmasStabian zonalur struqturebSi, rac damaxasiaTebelia energiis turbulenturi ukukaskadisTvis.

madloba. winamdebare naSromi Sesrulebuli iyo SoTa rusTavelis erovnuli samecniero fondSi mopovebuli grantis # 31/14 da evrokomiis me-7 CarCo programis grantis # 269198 “geoplazmas” (maria kiuris saerTa-Soriso mecnierTa gacvlis sqema) mier.

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navie-stoqsis gantolebis Sesaxeb zogierT RerZ-simetriul SmTxvevaSi

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ganxilulia RerZsimetriuli sxeulebis garsdena reinoldsis mcire ricxvis SemTxvevaSi. am SemTxvevaSi navie-stoqsis gantoleba wrfivdeba da miiReba stoqsis wrfivi gantoleba Sesabamisi sawyisi da sasazRvro pirobebiT. zogierT kerZo SemTxvevaSi miRebulia cxadi formulebi siCqarisa da gadaadgilebis ZabvebisTvis. ganxilulia agreTve cvalebadi sazRvris SemTxvevac.

Zlieri anizotropuli grigaluri turbulentobis speqtrebi geokosmosur sivrceSi

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naSromi eZRvneba damagnitebul kosmosur plazmur garemoSi mimdinare turbulenturi procesebis gamokvlevas. aseT garemoSi aramdgradobebis ganviTarebiT SesaZlebelia warmoiqmnan eleqtromagnituri mciremasStabiani Zlierad lokalizebuli arawrfivi grigaluri struqturebi, romlebsac gadaaqvT

CaWerili nawilakebi. plazmaSi gadaadgilebisas es struqturebi iwveven simkvrivis, eleqtruli da magnituri velebis SesamCnev fluqtuaciebs da aaqtiureben gadatanis procesebs garemoSi. amasTan eqsperimentze miRebuli simkvrivis fluqtuaciis speqtris maCvenebeli gacilebiT aRemateba susti turbulentobis Teoriis mier nawinaswarmetyvelebs. Cvens modelSi ganxilul grigalur struqturebs SeuZliaT gamoiwvion Zlieri grigaluri turbulentoba. turbulenturi dineba ganixileba rogorc Zlierad lokalizebul, sustad urTierTqmed erTnairi grigalebis ansambli. sxvadasxva amplitudiani grigalebi SemTxveviTad arian ganawilebuli garemoSi (urTierTdajaxebebis gamo). maT aRsawerad iqna gamoyenebuli statistikuri meTodi. mocemul modelSi daSvebulia, rom stacionaruli turbulentoba formirdeba urTierT konkurentuli efeqtebis dabalansebiT: grigalebis spontanuri generireba, romelic ganpirobebulia SeSfoTebaTa frontis arawrfivi grexiT, didmasStabian SeSfoTebaTa energiis transportireba mokle masStabian SeSfoTebebSi da am masStabebSi maTi dajaxebiT mileva. inerciul areSi energiis gadatana masStabebis mixedviT xdeba struqturebis SeerTebiT maTi urTierTdajaxebisas. miRebulia talRuri ricxvebis mimarT eleqtromagnituri energiis stacionaruli speqtris axali saxe, romelic ecema xarisxovani kanoniT $\left\langle |B_k|^2 \right\rangle \sim k^{-8/3}$, rac karg TanxvedraSia uaxles satelitur (magnitosferul, ionosferul) da laboratoriuli dakvirvebebis monacemebTan. Gamokvleulia dedamiwis magnitosferul kudSi dinebis kinematikuri parametrebisa da magnitometruli gazomvebi satelit “THEMIS” monacemebis mixedviT. Seswavlilma speqtrebma gviCvena, rom speqtris xarisxis maCvenebeli damokidebulia magnitosferos mdgomareobaze. kerZod, Cvens mier gamokvleul droiT intervalSi speqtrebis saxes gansazRvravs magnitosferoSi mimdinare magnituri Stormebi. Catarda plazmuri grigalebis urTierTdajaxebebis kompiuteruli modelireba, romelmac daadastura warmodgenili turbulentobis formirebis scenaris SesaZlebloba.

madloba. winamdebare naSromi Sesrulebuli iyo SoTa rusTavelis erovnuli samecniero fondSi mopovebuli grantis # 31/14 da evrokomiis me-7 CarCo programis grantis # 269198 “geoplazmas” (maria kiuris saerTa-Soriso mecnierTa gacvlis sqema) mier.

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gamtar siTxeSi usasrulo forovani firfitis brunvis arastacionaruli amocana cvladi gamoJonvis siCqarisa da eleqtrogamtareblobis SemTxvevaSi magnituri velisa da siTbogadacemis gaTvaliswinebiT

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mimdevrobiTi miaxloebis meTodiT Seswavlilia gamtar siTxeSi usasrulo forovani firfitis brunvis arastacionaruli amocana magnituri velisa da siTbogadacemis gaTvaliswinebiT cvladi eleqtrogamtareblobisa $\sigma=\sigma_0\frac{T}{T_0}$ da gamoJonvis siCqaris $\upsilon_w=\upsilon_0\frac{T}{T_0}$ SemTxvevaSi.

dinamikuri da siTburi sasazRvro fenaTa sisqeebis gansasazRvravad miRebulia Sesabamisi diferencialuri gantolebebi da Cawerilia maTi zusti amoxsnebi zogierT kerZo SemTxvevaSi, rodesac gamoJonvis siCqare icvleba sxvadasxva kanoniT da sasazRvro fenaTa sisqeebs Soris arsebobs $\delta_T(t)=\gamma\delta(t)$ saxis damokidebuleba.

gamoTvlilia dinebis yvela fizikuri maxasiaTebeli.

sanapiro zolSi talRuri procesebis modelireba

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naSromSi ganixileba SemTxveviTi talRebis ricxviTi modeli talRebTan mimarTebaSi. es modeli Sedgeba sami qve-modelisagan: 1. modeli, romelic gamoiyeneba mravalmxrivi da SemTxveviTi talRis transformaciisTvis; 2. zedapirze mbrunavi (mgoravi) evoluciis modeli; 3. modeli, romlis meSveobiTac gamoiTvleba vertikaluri ganawileba da talRis siCqaris mniSvneloba. talRis gamoTvla donis mixedviT fasdeba talRis asimetriis Teoriis safuZvelze dayrdnobiT. modeli uzrunvelyofs natanis xelsayrel gamoyenebasa da morfologiur cvlilebebs talRebisa da dinebebis mixedviT.

samaSvelo zurgsakidi mowyobilobiT aRWurvili biomeqanikuri sistemis maTematikuri modelireba

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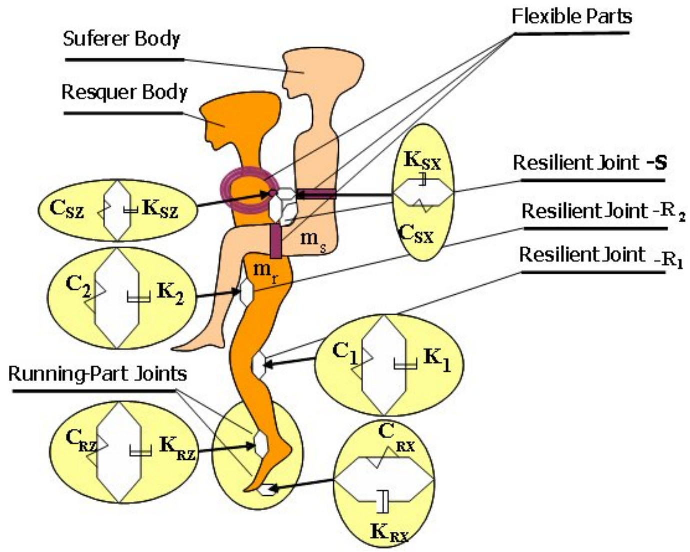
martivi samaSvelo zurgsakidi Rveduri mowyobiloba (nou-hau"), romelic gaTvaliswinebulia stiqiuri ubedurebebisa da sxva sagangebo situaciebis dros dazaralebulTa gadasayvanad, warmoadgens tradiciuli sakacis alternativas. aseve, samxedro miznebisaTvis, taqtikuri aRWurvilobebis mwarmoebel kompania "Agilite Gear"-is mier Seqmnilia zurgsakidi samaSvelo mowyobiloba [1, 2].

mowyobiloba iZleva gadasayvani adamianis wonis gadanawilebis SesaZleblobas tradiciuli jdomis Sesabamisad. mis meqanikur struqturas safuZvlad udevs sacdeli moqnili samaSvelo maryuJis axlad Seqmnili nimuSi [3].



biomeqanikuri sistemis rxeviTi dinamikuri procesebi aRwerilia la' granJis meore gvaris diferencialur gantolebaTa sistemiT [4].

$$1.(M_r+M_s)\ddot{X}_R=(M_r+M_s)g-C_{RX}X_R-K_{RX}\dot{X}_R;$$

$$2.M_s\ddot{X}_S-C_{SX}(X_R-X_S)-K_{SX}(\dot{X}_R-\dot{X}_S)=0;$$

$$3.(M_r+M_s)\ddot{Z}_{RP}=(M_r+M_s)g-C_{RZ}Z_{RP}-K_{RZ}\dot{Z}_{RP};$$

$$4.(M_r+M_s)\ddot{Z}_{RJR_1}-C_1\left(Z_{RJR_1}-Z_{RP}\right)-K_1\left(\dot{Z}_{RJR_1}-\dot{Z}_{RP}\right)=0;$$

$$5.(M_r+M_s)\ddot{Z}_{RJR_1}-C_2\left(Z_{RJR_1}-Z_{RJR_1}\right)-K_2\left(\dot{Z}_{RJR_1}-\dot{Z}_{RJR_1}\right)=0$$

$$6.M_s\ddot{Z}_{RJS}-C_{SZ}\left(Z_{RJS}-Z_{RJR_1}\right)-K_{SZ}\left(\dot{Z}_{RJS}-\dot{Z}_{RJR_1}\right)=0.$$

samaSvelo zurgsakidi mowyobilobis sagangebo situaciebSi masobrivi moxmareba SesaZlebelia specialuri momzadebis gareSe _ dazaralebulTa gadasayvanad maSvelTa gaZnelebuli gadaadgilebis

pirobebSi, rogoricaa: cicabo ferdobebi, viwro xeobebi, oRro-CoRro reliefi, Caxergili nangrevebi da sxva.

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A

amwe-satransporto da sagzao manqanebis muSa aRWurvilobis struqturuli analizi

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amwe-satransporto da sagzao manqanebis muSa aRWurvilobebi warmoadgens rTul sivrciT sistemebs, romelTa elementebi saxsruladaa dakavSirebuli erTmaneTTan. ZiriTadad gamoyenebulia cilindruli da sferuli saxsrebi. garkveul meqanizmebSi gvxvdeba zedmeti bmebi, ris gamoc rgolebSi zomebis xazovani dakuTxuri gadaxrebis gamo meqanizmebis muSaoba xdeba RreCoebis meSveobiT an konstruqciis daZabviT.

mizanSewonilia Seiqmnas racionaluri meqanizmebi, romlebic TviTregulirebadia da ar iwvevs konstruqciis winaswar daZabul mdgomareobas.

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eleqtruli manqanebis Rerovani modelebi

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eleqtrul manqanebSi energiis eleqtromeqanikuri gardaqmna xdeba sivrceSi, sadac Tavmoyrilia eleqtromagnituri velis energia. manqanis eleqtromagnituri veli warmoiqmneba mis gragnilebSi arsebuli deniT. eleqtruli manqanebis magnituri velebi maTi sivrcul-droebiTi araerT-gvarovnebis gamo zedmiwevniT rTulia. manqanis magnituri velis Seswavlas didi mniSvneloba aqvs misi muSaobis gagebisa da analizisaTvis.

SemoTavazebuli midgomis ZiriTadi idea mdgomareobs imaSi, rom eleqtrul manqanebSi energiis eleqtromagnituri da eleqtromeqanikuri gardaqmna aRwerili iqnas rogorc erTnairi elementebis eleqtromeqanikuri urTierTqmedebis Sejamebis Sedegi. aseTi elementebis saxiT aRebulia eleqtruli denis gamtari Reroebi, romlebic ganlagebulia manqanis RerZis gaswvriv an marTobulad. leqtruli denis gamtari Reroebis daxmarebiT xdeba aramarto eleqturi manqanebis gragnilebis (aRznebis gragnili, statoris gragnili, dempferuli gragnili), aramed magnituri gularebis wriuli denebis modelireba.

ramodenime sabaziso zedapiris mqone garsTa Teoriis zogierTi gamoyeneba

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ramodenime sabaziso zedapiris mqone garsTa Teoria igeba erTi kinematikuri hipoTezis safuZvelze. Ees hipoTeza aZlevs saSualebas miaxloebiT avagoT konstruqciis erTi fenis (garsis) wertilebis samgazomiliani gadaadgilebis velis ori sabaziso zedapiris wertilebis gadaadgilebis velis gamoyenebiT. TeoriaSi ganzogadoebuli koordinatebis (gadaadgilebebis) ricxvi zustad Seesabameba ganzogadoebuli Zalebis ricxvs.

naSromSi moyvanilia praqtikuli amocanebis magaliTebi, sadac maTematikuri modelebis agebisas gamoiyeneba ramodenime sabaziso zedapiris mqone garsTa Teoria.

ganaTebis gavlena Senobis konstruqciis sivrciTi gadawyvetisas

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sibrtyeze figuris dagegmilebis dros figurasa da mis gegmils Soris warmoiqmneba naTesauri Sesabamisoba. ase magaliTad, myardeba Sesabamisoba figuris gegmilsa da Sveul gegmilTsibrtyeze mis Crdils Soris. Sveul gegmilTsibrtyeze horizontaluri wrewiris Crdilis agebis gaaanalizebisas Cans, rom gardaqmnis (damatebiTi dagegmilebis) Sedegad wrewiri gadadis elifsSi.

zedapiri SeiZleba warmodgenil iqnas, rogorc misi mxebi sibrtyeebis Semomvlebi. raime mimarTulebiT mxebi sibrtyis gadaadgilebisas Sexebis wertilebi mxeb sibrtyeze toveben nakvalevs. Sexebis wertilebis erToblioba zedapirze warmoqmnis wirs. am ukanasknels ewodeba maxasiaTebeli wiri da misi mimarTuleba, garkveulwilad, dakavSirebulia mxebi sibrtyis gadaadgilebis mimarTulebasTan. unda aRiniSnos, rom Tu zedapiris irgvliv Semowerilia ganfenadi zedapiri, maSin Sexebis wiris mxebi da ganfenadi zedapiris msaxveli zedapirze SeuRlebulni arian.

zedapirebis sakuTari da dacemuli Crdilebis agebisas SeiniSneba saintereso afinuri, proeqciuli da diferencialuri urTierTkavSirebi. naSromSi es naTesauri urTierTkavSirebi ganixileba nebismieri ganaTebis SemTxvevaSi konusuri zedapiris Crdilis agebis magaliTze. ganaTeba xorcieldeba Sveuli gegmilTsibrtyis paralelurad. Crdilis SemomsazRvreli msaxveli ganisazRvreba, rogorc meoTxe harmoniuli elementi SemomsazRvrel msaxvelebsa da sinaTlis sxivTan mimarTebaSi.

Camoyalibebulia wertilis agebis grafikuli algoriTmi sinaTlis sxivisa da ganapira msaxvelisadmi marTobuli an paraleluri wrfeebis gamoyenebiT. amis safuZvelze dadgenilia analitikuri Tanafardoba, romelic saZiebeli wertilis koordinatebs akavSirebs wrewiris radiusTan, sinaTlis sxivisa da msaxvelis daxris kuTxeebTan.

brunviTi konusis Crdilis agebis magaliTze miRebuli Sedegebi SesaZlebelia gavrceldes zogad SemTxvevebSi. aqve gansazRvrulia sxivis daxris kuTxesa da mis gegmilebs Soris damokidebuleba.

narCeni Zabvebis roli magistraluri milsadenebis rRvevisas

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konstruqciis SeduRebisa da daduRebis procesSi masSi warmoiqmneba Zabvebi araTanabari moculobiTi cvlilebebis Sedegad, romlebic gamowveulia sxvadasxva movlenebiT. am Siga Zabvebma SeiZleba gamoiwvios ara marto konstruqciis deformacia, aramed misi rRvevac [1-3]. aseTi SemTxvevbi gansakuTrebiT damzianebelia garemos ekologiuri mdgomareobisaTvis didi gabaritebis rTuli SenaduRi konstruqciebis damzadebisa da eqspluataciis dros. aseT konstruqciebs miekuTvneba didi diametris magistraluri milsadenebi, kerZod, navTob da gazsadenebi. maTze yovelwliurad avariebis didi raodenoba fiqsirdeba.

magistraluri milsadenebis qselebis avariebis ZiriTad mizezs xSirad ZiriTadi liTonisa da SenaduRi SeerTebis korozia warmoadgens, romelic gansakuTrebiT saSiSia konstruqciebSi Siga Zabvebis arsebobisas, radganac SeiZleba ganviTardes liTonis koroziuli daskdoma Zabvis qveS. rogorc [3] naSromSia miTiTebuli, avariebis 40%-mde swored koroziuli daskdomis Sedegad xdeba. amasTan, gazsadenebis rRvevaTa naxevari SemTxvevebisa SenaduRi SeerTebis zonebSi mimdinareobs, rac adgilobrivi narCeni Zabvebis arsebobis Sedegia. roca aRniSnul narCen Zabvebs milSi muSa Zabvebi emateba, SeiZleba daCqardes SenaduRi SeerTebis zonaSi bzaris Casaxvis stadia da warimarTos bzaris zrdis stadia, milsadenis rRvevamde. Ees procesi gansakuTrebiT intensiuri xdeba koroziuli movlenebis ganviTarebisas.

arsebobs SeduRebis narCeni Zabvebis moxsnis mravalnairi meTodi: gaWedvis, mokumSvis, vibraciuli, dartymiTi, ultrabgeriTi damuSaveba, adgilobrivi Termuli damuSaveba, moculobiTi Termuli damuSaveba da sxva. Zalian kargi Sedegi miRebulia Termuli damuSavebis meTodebis gamoyenebisas.

garda amisa, saWiro gaxda narCeni Zabvebis sidideebze zegavlenis moxdena ukeTesi Tvisebebis mqone saSemduReblo masalebis gamoyenebis gziT. Aam mizniT [3] naSromSi Catarebuli iyo kvlevebi milebis SeduRebisaTvis saSemduReblo mavTulis Sesaqmnelad, romlis saSualebiTac SesaZlebeli iqneboda SenaduR nakerSi Seqmniliyo mkumSavi narCeni Zabvebi, anda gamWimi da maTi sidide bevrad naklebi yofiliyo (ziogjer 5-jerac ki), vidre arsebuli teqnologiisas.

kvlevebi Catarebuli iyo 17Г1С da 15ХСНД foladebis Св-08Г2С da Св-08ХМ (ferit-perlituri), Св-06Х19Н9Т (austenituri) da damuSavebuli martensituli Sedgenilobis fxvnilgula mavTuliT (4,5-5,5 Ni %, 0,5-0,6% Cr, 0,3-0,5% Mo, 1,3-1,5% Mn, 0,3-0,4% Si, 0,14-

0,2% V, ≤0,019% It, ≤0,05% C, danarCeni – rkina) SeduRebiT. damcav garemod gamoiyeneboda naxSiror-Jangis airi, AH-60 da AH-348 markis flusebi.

aRniSnuli Sedgenilobis mavTuliT SeduRebis Semdeg meqanikurma gamocdam aCvena, rom nakeris liTonis dartymiTi siblante utoldeboda ZiriTadi liTonis dartymiT siblantes da teqnologiuri simtkice mTlianad akmayofilebs normatiul moTxiv-nebs didi diametris SenaduRi milebisaTvis.

бaSromSi [4] gamokvleulia nakeris sigrZeze qimiuri da fizikuri araerTgvarovnebis SeqmniT Sena-duRi SeerTebis teqnologiuri da konstruqciuli simtkicis amaRlebisa da narCeni Zabvebis Semcirebis SesaZlebloba.

eqsperimentebi Catarebuli iqna 17Г1С da 15ХСНД foladebis Св-08ХМ, Св-06Х19Н9Т da cvalebad-cikluri (Св-08ХМ+Св-06Х19Н9Т) fxvnilgula mavTulis ga-moyenebiT, damcav airSi da AH-348 flusis qveS. vva-raudobdiT, rom SenaduR SeerTebaSi bzarebis war-moqmnis mimarT winaaRmdegobis gazrda SesaZlebeli iqneboda cvalebad-cikluri saSemduReblo masale-bis gamoyenebiT, SeduRebis Zabvebis relaqsaciis xarjze. Cvens SemTxvevaSi gamWimavi narCeni Zabvebi 2-4-jer Semcirda,Pperlituri da austenituri masale-biT SesrulebuL nakerebTan SedarebiT.

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mTagorian pirobebSi misabmeliT momuSave sasof-lo sameurneo daniSnulebis 4×4 tipis srulamZra-viani avtomobilis transmisia funqcionirebs did sa-datvirTvo reJimebSi. eqspluataciis procesSi, gan-sakuTrebiT sasoflo sameurneo tvirTebis (Tiva, simindi, bamba da sxv.) gadazidvisas, warmiSoba ayiravebis saSiSroebidan gamomdinare avtomobilis mdgradobis sakiTxi. es problema ufro aqtualuria Tu avtomobili moZraobs ferdobze da gza daferde-bulia moZraobis mimarTulebis ganivad.

sasoflo sameurneo daniSnulebis 4×4 tipis sru-lamZraviani avtomobilis dayvaniTi samuSaoebis Ca-tarebisas didi yuradReba eTmoboda maT eqsp-luatacias Waobian gauval adgilebSi, xolo maTi mTagorian pirobebSi ferdobze moZraobis kvlevebis ricxvi TeoriaSi Zalian mcirea.

problemis gadasaWrelad moxda sasoflo sameurneo daniSnulebis srulamZraviani avtomobilis ferdobze moZraobis maTematikuri modelis srulyofa, romelSic garda sxva parametrebisa gaTvaliswinebulia gverdiTi mimarTulebiT saltis sixistisa da demferebis gavlena, agreTve ferdobze moZraobisas avtomobilis manevruloba mosaxvevSi Sesvlisas avtomobilis siCqarisa da moculobiTi masis gaTvaliswinebiT. es maxasiaTeblebi unda ganisazRvros saltis gamocdisas sastendo pirobebSi.

geometriuli modelireba klasikuri mxazvelobiTi geometriis aratradiciuli meTodebiT

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bunebaSi arsebuli fizikuri, qimiuri, biologiuri da sxva movlenebi xSirad warmodgebian sxvadasxva geometriuli formebiTA da maRali rigis gardaqmnebiT. Ggeometriuli modelireba ki xasiaTdeba rogorc kvlevis mimarTuleba, romelic ZiriTadad ixilavs, umetesad mxazvelobiTi geometriis meTodebiT, mocemuli sivrcisa da misi kuTvnili obieqtebis modelebis agebis xerxebs da meTodebs. nebismieri xerxiT geometriuli modelirebisas yovelTvis ismis kiTxva: ra, rogor, raze, da romeli meTodiT aisaxeba? sxva sityvebiT rom vTqvaT, rogori simravle igulisxmeba im geometriul formaSi, romlis asaxvac unda moxdes. rogori simravle iqneba asaxuli geometriuli forma. ra urTierTdamokidebuleba eqnebaT asasax da asaxul formebs – urTierTgardaqmnis rogor kanonebs daeqvemdebarebian isini. aseve mocemulia asasaxi da asaxuli formebis SesaZlo variantebi, erTmaneTTanaa Sedarebuli am formebis SesaZlo variantebi mxazvelobiTi geometriis sxvadasxva meTodebSi: monJis meTodSi, perspeqtivaSi, ricxobrivniSnulebian gegmilebSi, sferos stereografiul gegmilebSi, aqsonometriaSi, maioris sasuraTe meTodSi, fidleris ciklografiaSi da sxva. konstruirebuli formis Seqcevadi gamosaxulebis asagebad, ganxiluli meTodebidan gamoyofilia is gamosaxulebebi, romelTa asaxvis simravlec aris dekartes simravle an misi qvesimravle. aseve ganxilulia asasaxi da asaxuli formebis mixedviT geometriuli modelirebis SesaZlo oTxi ZiriTadi mimarTuleba.

გამონაბოლქვი აირების თბოცვლის პროცესზე მოქმედი ფაქტორების გავლენის ხარისხის მათემატიკური მოდელი

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gamonabolqvi airebis Tbocvlis procesis mimdinareobaze mniSvnelovan gavlenas axdens wvis produqtebis moZraobis siCqaris, masis, temperaturis cvlileba da Tbomcvlelis zedapirebze danaleqi muris sisqe. Tu gavaanalizebT gamonabolqvi airebis moZraobis dinamikas gamomSveb sistemaSi, romelic uSualod damokidebulia Zravis muSaobis reJimebze, misi siTburi energiis mniSvneloba cvalebadia da mimdinare Tbocvlis procesebi arastacionaluria, rac uSualod damokidebulia nakadis moZraobis siCqaris cvalebadobis xasiaTze, nakadis masisa da temperaturis cvalebadobze, Tbomcvlel zedapirebze wvis produqtebis danaleqis sisqeze da nakadis pulsaciis xasiaTze da a.S. amitom namuSavari airebis siTburi energiis utilizaciisas Tbocvlis procesis gaangariSebis dros gaTvaliswinebuli unda iyos Zravis eqspluataciis pirobebis gavlena – arastacionaluri siTburi nakadis da Tbomcvlel zedapirze wvis produqtebis danalaqis sisqis mniSvneloba. SerCeuli kompaqturi milwibovani TbomcvlelisaTvis Sedgenilia Tbocvlis procesis maTematiuri modeli, romelic aRwers Tbogadacemis process cxeli (gamonabolqvi airebi) Tbogadamtanidan civ Tbogadamtanze (samcivro agenti) da vRebulobT gantolebaTa sistemas. gantolebaTa sistemaSi cnobili sidideebis CasmiT da integrebiT miiReba gamonabolqvi airebis siTburi engergiis Tbogadacemis procesis maTematiuri modeli, romelic gansazRvravs Tbocvlis i-ur monakveTze siTbur nakads.

Tbocvlis procesebis gaangariSebis da kompaqturi Tbomcvlelis SerCevisaTvis saWiroa oTxi geometriuli parametris analizi:

- eqvivalenturi diametri - damokidebulia cocxali kveTis farTobze da eTreulovani arxis perimetrze, romelic Seqmnilia or mezobel wiboebs Soris;
- kompaqturobis koeficienti - damokidebulia Tbomcvlelis mTlian zedapirze da moculobaze, romelic moTavsebulia gawibovnebis sivrceSi.
- cocxali kveTis koeficienti - damokidebulia cocxali kveTis farTobze da gawibovnebiT moculi adgilis mTlian frontalur kveTze. mocemuli koeficienti axasiaTebs kveTis Sevsebas wibovnebis ganiv kveTSi.
- gawibovnebis kuTri zedapiri - damokidebulia wiboebis da Tbomcvlelis mTliani zedapiris farTobze, romelic axasiaTebs Tbogadamcemis jamuri zedapiridan gawibovnebuli farTobis wils.

damaxasiaTebeli zomebi da parametrebi upirobod aRweren konkretuli Tbomcvlelis gawibovnebis

Tvisebas. amavdroulad aRniSnul SemTxvevaSi advilad miiReba Tbomcvlelis is geometriuli parametrebi, romlebic gamoiyeneba maTi gaangariSebis dros. aseve sayuradReboa Tbomcvlelis hidravlikuri maxasiaTeblebi - aRweren wnevis danakargis sidides, romelic ixarjeba warmoqmnili dinebiT reJimisaTvis Tbogacemis procesis intensiurobis gasazrdelad.

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mravalfenovani wyvetilparametrebiani sivriTi sistemebis deformadoba da mdgradoba

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ganxilulia mimoxilviTi namuSevrebi mdgradobaze gaangariSebis analiTikur meTodebze firfitebis da filebis geometriuli arawrfivobis da mdgradobis gaTvaliswinebiT, romlebsac aqvT regularobis rRvevebi. am araregularobebis gasaTvaliswineblad gamoyenebulia ganzogadebuli funqciebi, romlebic Seiyvaneba sawyis geometriul da fizikur fardobebSi. miRebuli impulsur koeficientebiani diferencialuri gantolebebis amonaxsnebi warmodgenilia regularuli da wyvetili funqciebis kombinaciiT, rasac mivyevarT swrafad krebad mwkrivebamde da gaangariSebis martiv algoriTmebTan.

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milsadenSi moZravi navTobis SeTbobaze moxmarebuli energetikuli danaxarjebis analizi

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navTobi moipoveba dedamiwis siRrmidan WaburRilebis saSualebiT da transportireba xorcieldeba milsadenuri transportiT, ramdenime aseul kilometrze garkveuli wnevisa da temperaturis pirobebSi.

siblante warmoadgens navTobis ZiriTad maxasiaTebel fiziko-qimiur parametrs da mniSvnelovnad gansazRvravs moZraobis siCqares milsadenSi. TviTon siblante ki temperaturaze sakmaod damokidebuli sididea da garkveul temperaturul diapazonSi ramdenjerme icvleba. literaturuli monacemebis mixedviT [1], temperaturis 20^0C-dan 40^0C-mde cvlilebisas navTobis dinamikuri siblante 13240 mpa.wm-dan mcirdeba 2020 mpa.wm-de, Tumca cvlilebis diapazoni mniSvnelovnad ganisazRvreba mopovebis adgilmdebareobiT.

aRniSnulidan gamomdinare SeiZleba vimsjeloT terminalebSi tankeris Catvirtvis procesis daCqarebis SesaZleblobaze, risTvisac mimarTaven navTobis SeTbobas. Tbogadacemisa (1) da Tburi balansis (2) gantolebebi

$$Q = K.\overline{\Delta}t.F \quad (1)$$

$$Q = W_1 f_1 \rho_1 C_1 (t_1' - t_1'') = W_2 f_2 \rho_2 C_2 (t_2' - t_2'') \quad (2)$$

sadac K – siTbogadacemis koeficientia da damokidebulia siTxis simkvriveze, siblanteze, Tbocvlis monawile zedapirebis formaze da sxva. F- Tbogadamcemi zedapiris gasaTbobi farTia; Δt – cxel da civ Tbogadamtanebs Soris saSualo temperaturuli dawnevaa; W_1 da W_2 – Tbogadamtanebis moZraobis siCqarea; ρ_1 da ρ_2 – Tbogadamtanebis simkvriveebia; C_1 da C_2 – Tbogadamtanebis siTboteva-dobebia; f_1 da f_2 – Tbogadamtanebis gasadinebeli kveTebis farTobia. t_1', t_2', t_1'', t_2'' - Tbogadamtanebis sawyisi da saboloo temperaturebia.

Tbomcvlelis gaangariSebis dros sagulisxmoa saSualo temperaturuli dawnevis ($\overline{\Delta}t$) sididis damokidebuleba Tbogadamtanebis moZraobis sqemaze da siCqareze. Uunda aRiniSnos, rom Tanabar pirobebSi Semxvedri dinebis Tbomcvlelebi, Tbocvlis gacilebiT uketesi intensivobiT xasiaTdebian vidre erTmxrivi dinebis aparatebi. aRniSnulis gamo maT gaaCniaT SedarebiT mcire zomebi da upiratesobiT sargebloben ekonomiurobis TvalsazrisiT.

naSromSi ganxilulia gamaTbobelSi (mili-milSi) moZravi navTobis SeTbobis procesi da misi gavlena gadatvirTvis procesis intensivobaze.

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milsadenSi navTobis moZraobis siCqareze temperaturis cvlilebis gavlenis eqsperimentuli kvleva

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bolo aTwleulebSi navTobproduqtebze moTxovnebis zrdam msoflios mecnierebis winaSe dasva amocana, romelic gulisxmobs navTobis udanakargod mopoebas da mis swraf transportirebas momxmarebel qveynebSi. dReisaTvis xmeleTze navTobis transportirebis yvelaze metad gavrcelebul saSualebas milsadenuri transporti warmoadgens. aqedan gamomdinare Cvens mier SemoTavazebuli idea milsadenSi navTobis moZraobis siCqareze temperaturis cvlilebis gavlenis eqsperimentuli kvleva metad mniSvnelobania da perspeqtiul kvlevas warmoadgens.

milsadenSi navTobis moZraobis xarji damokidebulia milis diametrze da navTobis moZraobis siCqareze:

$$Q = \omega \cdot \upsilon,$$

sadac ω -milsadenis ganivi kveTis farTobia, m^2.
υ - navTobis moZraobis saSualo siCqarea. m/wm.

navTobis moZraobis siCqare Tavis mxriv damokidebulia navTobis temperaturaze. aqedan gamomdinare, rom davadginoT milsadenSi navTobis xarjis cvlilebis damokidebuleba temperaturis cvlilebaze umjobesia es procesi SeviswavloT eqsperimentuli gziT specialurad Seqmnil danadgarze.

milsadenSi moZravi navTobis hidrodinamikis Sesaswavlad gamoviyeneT danadgari, romelic Sedgeba navTobiT Sevsebuli avzisagan. centridanuli tumbos saSualebiT navTobi Semwovi milidan gadadis grZiv milsadenSi. am ukanaskneliT ivseba mudmivdoniani avzi, saidanac navTobi miewodeba mudmivi diametris milsadens, romelSic xdeba navTobis moZraobis siCqaresa da xarjze moZravi masis temperaturis cvlilebis gavlenis Seswavla. danadgarze agreTve damagrebulia: mudmivi donis avzi, piezometrebi, onkanebi, samkuTxa wyalsaSvi, damawynarebeli, zedmeti navTobis avzSi damabrunebeli milsadeni, Termometri.

centridanul tumbos CarTvidan garkveuli drois Semdeg, rogorc ki navTobis moZraoba damyarebul xasiaTs miiRebs. TermometriT vzomavT milsadenSi gamavali navTobis temperaturas . moculobiTi wesiT ganvsazRvravT navTobis xarjs, xolo Semdeg- moZraobis saSualo siCqares υ. Cxrilebidan vpoulobT siblantis kinematikur koeficientis sidides, xolo $Re = \upsilon \cdot d / \nu$ formulidan-reinoldsis ricxvis mniSvnelobas. cda unda gavimeoroT ramodenimejer sxvadasxva temperaturisaTvis. miRebuli SedegebiT vagebT damokidebulebis mrudebs.

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sivrciTi moZraobis marTvis erTi amocanis Sesaxeb

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** არიელის უნივერსიტეტი. არიელი, ისრაელი

სპინორულ წარმოდგენათა საშუალებით პირველად მოხდა სივრცით ბრუნვათა აღწერა. შედეგად მიღებულ იქნა მათი დინამიკის აღწერის მარტივი დამოკიდებულება [1]. მიღებული შედეგებით შესაძლებელი გახდა სივრცით ბრუნვათა სამგანზომილებიანი ამოცანის ერთგანზომილებიანზე დაყვანა. ტერმილანული მართვის სხვადასხვა ამოცანის გადასაწყვეტად გამოყენებულ იქნა ვარიაციული მეთოდი. მიღებულ იქნა მარტივი და სანდო ალგორითმები, რომელთა საშუალებითაც პრაქტიკულად გადაწყდა ტერმინალური მართვით დამუხრუჭების პროცესის მნიშვნელოვანი ამოცანა. განხილულ იქნა მართვის პროცესების გარდამავალი რეჟიმების მოდელები. დამუშავდა მათი წარმოშობის კრიტერიუმები. განისაზღვრა ოპტიმალური ტრაექტორიები, სიჩქარისა და აჩქარების ოპტიმალური კანონები, რომლებიც ამკაყოფილებენ შესაბამის ზღვრულ პირობებს. წარმოდგენილია სივრცითი ბრუნვის დამუხრუჭების პროცესის მოდელირების დეტალური შედეგები.

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Ddrekadobis brtyeli Teoriis erTi nawilobriv ucnob sazRvriani amocanis Sesaxeb

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განხილულია დრეკადობის ბრტყელი თეორიის ამოცანა ერთგვაროვანი იზოტროპული ფირფიტისათვის , რომელსაც კომპლექსური ცვლადის სიბრტყეზე უკავია მარტივადბმული არე, რომელიც შემოსაზღვრულია ამოზნექილი ტეხილითა და უცნობი კოტურით. საძებნია უცნობი კონტურის ფორმა იმ პირობით, რომ მასზე ნორმალური ტანგენციალური ძაბვა იყოს მუდმივი. ნაჩვენებია, რომ უცნობი კონტურის განტოლებები შეიძლება მიღებული იქნას მრავალკუთხედის ნახევარსიბრტყეზე კონფორმულად ამსახავი კრისტოფელ –შვარცის ცნობილი ფორმულებიდან.

blanti drekadi Zelis rxevis amocana, rodesac ganmsazRvreli Tanafardoba Seicavs wiladuri rigis warmoebuls

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ganixileba usasrulo, erTgvarovani blanti drekadi Zelis rxevis amocana, rodesac ganmsazRvreli Tanafardoba deformaciasa da daZabulobas Soris mocemulia Semdegi formiT:

$$\sigma(t,x) = E\eta^{\beta} D^{\beta} \varepsilon(t,x), \quad 0<\beta<1.$$

sadac D^{β} aRniSnulia wiladuri rigis warmoebuli riman-liuvilis azriT. Tavdapirvelad ganixileba SemTxveva, rodesac gareSe datvirTva damokidebulia mxolod sivrciT koordinatze. napovnia amgantolebis amonaxseni zogad SemTxvevaSi. naCvenebia, rom β parametris kritikuli mniSvnelobebisaTvis e.i. roca $\beta=0$ da $\beta=1$ miRebuli amonaxseni emTxveva klasikuri hiperboluri da parabloluri gantolebebis amonaxsnebs. ganixileba agreTve SemTxveva, rodesac gareSe datvirTva damokidebulia droze periodulad.

CONTENTS

RELATED PROBLEMS OF ANALYSIS

სარჩევი

მყარ დეფორმად სხეულთა მექანიკა

ჰიდროაერომექანიკა

გამოყენებითი მექანიკა

ანალიზის მონათესავე საკითხები