

ABSTRACTS

Dahl Yu. M. **On solution of some differential equations of mechanics by operating method** // Vestnik St. Petersburg University. Ser. 10. 2013. Issue 4. P. 3–9.

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Application of an operating method to the solution of Cauchy problem for heterogeneous differential equation of n -degree is considered. The formula of this equation general integral is obtained. The operating method is also used for solving boundary-value problems of mechanics of solids. It appears very effective in analytical examination of bend and stability of elastic-prismatic rods. Bibliogr. 6. Il. 2.

Key words: differential equation, operating method, Cauchy problem, boundary-value problems, bend and stability of rods.

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Krivovichev G. V. **On one variant of the lattice Boltzmann equation method** // Vestnik St. Petersburg University. Ser. 10. 2013. Issue 4. P. 10–20.

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Modification of the lattice Boltzmann method is considered. The modified method is based on splitting of differential operator in Navier–Stokes equation and on the idea of instantaneous Maxwellisation of the distribution function. The problems for the system of lattice kinetic equations and for the system of linear diffusion equations are solved while one time step is realized. The efficiency of the method proposed in comparison with the ordinary lattice Boltzmann equation method is demonstrated on the solution of the problem of planar flow in cavern in wide range of Reynolds number and various grid resolution. Bibliogr. 41. Il. 1. Table 3.

Key words: lattice Boltzmann method, splitting method.

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Lapin Yu. P. **On constructing exact penalty functions** // Vestnik St. Petersburg University. Ser. 10. 2013. Issue 4. P. 21–31.

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There are a large number of publications dedicated to investigation and problems of using exact penalty functions. At present the method of exact penalty functions is widely used for solving optimization problems with constraints. But using this method involves certain difficulties. Particularly there are no simple techniques of calculating the acceptable values of penalty coefficients. The article discusses approaches to determine the value of penalty coefficients for convex problems during the execution of the optimization algorithm. Significant difficulties in forming the equivalent unconstrained optimization problems arise if the functions describing the original problem are not defined on the whole variable space. For such case it is proposed to use special extensions of functions from a feasible set of the original problem to the whole variable space. This approach also allows to overcome the problem of bad scalability of the original problem. Bibliogr. 9. Il. 1.

Key words: nondifferentiable optimization, penalty functions, convex extension of functions.

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Mazalova A.V. **Duopoly in queueing system** // Vestnik St. Petersburg University. Ser. 10. 2013. Issue 4. P. 32–41.

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A non-cooperative two-person game which is related to the queueing system $M/M/2$ is considered. There are two services which serve the stream of customers with exponential distribution with parameters μ_1 and μ_2 respectively. The stream forms the Poisson process with intensity λ . The problem of pricing and determining the optimal intensity for each firm in the competition and cooperation is solved. Increase of the number of players is also carried out. Bibliogr. 9. Tabl. 4.

Key words: duopoly, equilibrium prices, queueing system.

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Malamanov S.U. **Asymptotic behavior model of turbulence near the surface** // Vestnik St. Petersburg University. Ser. 10. 2013. Issue 4. P. 42–48.

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The paper deals with the asymptotic analysis of the equations describing fluctuating structure of the turbulent flow of incompressible fluid. In addition to conventional viscous sublayer and a “buffer” zone – another area adjacent to the surface, and whose size of comparable with the height of natural roughness is considered. For this region approximate equations for the components of the Reynolds stress tensor are obtained and their solutions are found. Bibliogr. 6.

Key words: asymptotic analysis, turbulence, pulsation, Reynolds stress, the natural roughness.

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Murzinov I.E. On construction of common Lyapunov function for a family of mechanical systems with one degree of freedom // Vestnik St. Petersburg University. Ser. 10. 2013. Issue 4. P. 49–57.

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Certain classes of families of nonlinear mechanical systems with one degree of freedom, which is described by second order differential equation are studied. There are two parameters, damping and rigidity coefficients, in these equations and we assume that switching can take place in these coefficients. The problem of stability and dissipativity of corresponding hybrid system, which contains a considered family of systems and a switching law, defining which system is active in every moment is investigated. Conditions of the existence of CLFs of the a given form are obtained using second Lyapunov method. Fulfilment of these conditions provides asymptotic stability of equilibrium positions of corresponding switched systems for any switching law. It is proved that for considered families of essentially nonlinear systems we can guarantee the existence of CLFs under weaker assumptions than for linear ones. Thus, in comparison with linear systems, nonlinear ones are “more stable” with respect to switching of parameters values. Theorems 1 and 2 can be used for the design of stabilizing controls for mechanical systems. Challenging direction for further research is extension of the obtained results to the switched nonlinear mechanical systems with several degrees of freedom. Bibliogr. 16.

Key words: nonlinear systems, mechanical systems, hybrid systems, stability, Lyapunov functions.

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Novoselov V.S. **On mathematical model of cardiac cells exitation** // Vestnik St. Petersburg University. Ser. 10. 2013. Issue 4. P. 58–65.

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Cardiac muscle cells perform three functions. Some of them automatically oscillate, others get excited and propagate active potential, the rest muscle fibers get excited and under electrical potential action contract thereby enabling pumping of blood. Each cell has specialized contacts with its heighloreng cells. Active heart potential is generated in the first type cells (pacemaker synchrony) in the sinoatrial node (SA), in the atrioventricular node (AV) and even in Purkinje fibers. Then with the help of the second type cells this potential propagates through the cardiac conduction system and activates atria and ventricular muscle fibers (the third type of cardiac cells). In the article the third type of cardiac cells are mainly examined. Mathematical models of the first and second types of cells are constructed in preceding works [7, 8]. The third type cardiac cells (myocardial cells) have a substantially more prolonged active potential as compared with axon spike. These cells are cable-like. The mechanical adhesion of myocardial cells is provided by adhering junction of an intercalated disk. The electrical joining of cells is provided by fissure openings in a junction. Such junctions make it possible for miocardiac cells to reach threshold excitation (cut-off) at the same time. The simplest mathematical model of miocardiac cell excitation with regard to traveling pulse structure and kinetic differential equations of cardiac cell contraction is constructed. Bibliogr. 11. Il. 1.

Key words: myocardial cells, structure of a traveling pulse, kinetic differential equations.

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Tregubov V.P., Radichkina A.O. **Mathematical model of left ventricle during the process of contraction** // *Vestnik St. Petersburg University*. Ser. 10. 2013. Issue 4. P. 66–72.

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The paper is devoted to mathematical modeling of left ventricle (LV) work during contraction and blood ejection to the blood vessel system. As opposed to preceding works actual left ventricle contours obtained by means of ultrasonic investigation was used in the construction of a proposed model. In addition the algorithm of contraction was constructed in such a manner that the blood stream volume flowing from the model corresponded to the experimentally measured stream volume ejected through the LV outlet hole, whose diameter stayed constant. For this purpose the special model parameter was defined for control of the contraction process. The dependence of this parameter on time was obtained as a result of the integral equation in which the desired function entered both in explicit and implicit forms and also entered the variable limit of integration. This desired function was obtained by means of the special algorithm for numerical solution. As a result the integral characteristic of the contraction process was obtained which may be used as additional information of pathology cases of LV work. Bibliogr. 4. Il. 10.

Key words: left ventricle, mathematical model, integral characteristic of contraction process, integral equation, numerical solution.

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Babin A. V. **Mathematical data processing of gated blood pool SPECT** // Vestnik St. Petersburg University. Ser. 10. 2013. Issue 4. P. 73–82.

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The problem of mathematical data processing of gated blood pool SPECT is considered. Gated blood pool SPECT is a radionuclide tomographic method which due to its high diagnostic accuracy and the large volume of the data is one of the most popular in the problems of estimation and visualization of the pumping function of heart ventricles. To solve the problem the following algorithms: building parametric heart images using wavelet transforms; determining volumes of left and right ventricles; building activity/time curve reflecting changes of blood filling of ventricles; building parametric images presented in the form of polar diagrams on whose grounds it is possible to judge time sequence of various ventricle departments movement are suggested. The problem of determine basic diagnostic parameters that characterize the work of heart ventricles is also defined. Bibliogr. 21. Il. 7.

Key words: wavelet, polar diagrams, gated blood pool SPECT.

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Bure V.M., Karpenko P.A., Svirkin M.V. **Information-logical model and implementation of information-analytical complex “Admission to higher education institution”** // Vestnik St. Petersburg University. Ser. 10. 2013. Issue 4. P. 83–89.

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The article is devoted to the development of methodology to automate the process of admission to a higher educational institution. On the base of analysis and formalization of the domain, construction of an information-logical model the implementation of a program complex that covers the entire spectrum of admission process automation is presented. Main propositions of using of hardware, information technology and software solutions of this complex are presented, items of administration and possibility of mathematical and analytical modules are highlighted. Bibliogr. 4. II. 4.

Key words: admission to higher education, admission to St. Petersburg University, network architecture, Microsoft SQL, .NET.

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Lopatkin G.S. **Approach to automated testing digital devices** // Vestnik St. Petersburg University. Ser. 10. 2013. Issue 4. P. 90–98.

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The methodology for automating the process of test development for electronic digital devices is described. The mode based on representation of the device as a software model is suggested. The method for creating a model of input signals is described. Bibliogr. 5. Il. 7.

Key words: test control, digital devices, modeling, logical interface, software model.

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Timoshenko D.M. **Combined method of face detection on images using Gaussian mixture model and Haar's cascades** // Vestnik St. Petersburg University. Ser. 10. 2013. Issue 4. P. 99–104.

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The well known Gaussian mixture model and the Viola–Jones algorithm are combined into one method which provides a high detection rate and a low false negative rate. A two-dimensional windowed discrete cosine transform is shown. Discrete cosine transform coefficients were used as learning features for a mixture model. Optimal parameters of Gaussian mixture model and the number of the first cosine coefficients are found out. The proposed method is compared with Viola–Jones approach on a large image database from social networks. Bibliogr. 17. Il. 4. Table 2.

Key words: face detection, image processing, pattern recognition, Viola–Jones, Gaussian mixture model, cosine transform.

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Karelin V. V., Fominyh A. V. **Measurement process control in dynamical systems** // Vestnik St. Petersburg University. Ser. 10. 2013. Issue 4. P. 105–109.

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The problem of observation process optimization of dynamical system motion under random perturbations is considered. Moreover, all types of uncertainty (both external perturbations and measurement error) are treated as random variables with given statistical characteristics. The transition function of the considered dynamic process contains a vector of unknown parameters. Using Bayesian method the original problem is reduced to the solution of a determinate optimal control problem. The paper demonstrates the possibility of using Bellman's principle of dynamic programming to the quick action problem with a nonlinear system. Under constrains on control examined the necessary and sufficient conditions of optimal control are found. The obtained results are illustrated on an example. Bibliogr. 4.

Key words: random variable, nonsmooth analysis, dynamic programming, strict extremum, necessary and sufficient conditions.

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