дится сопоставление аналитического решения задачи с решением, полученным с использованием метода конечных элементов. Некорректность поставленных задач (прямой и обратной) преодолевается с использованием метода регуляризации А.Н. Тихонова.

Ключевые слова: пластина, ребро жесткости, ряд Фурье, преобразование Лапласа, условие контакта, уравнение Вольтерра, метод регуляризации.

Один метод комплексного анализа решения задач фильтрации в неоднородных пространственно искривленных нефтегазовых пластах / С. В. Ярощак // Вісник НТУ «ХПІ». Серія: Математичне моделювання в техніці та технологіях. – Харків: НТУ «ХПІ», 2015. – №6 (1115). – С. 200 – 206. Бібліогр.: 8 назв. – ISSN 2222-0631.

Разработан метод решения задач фильтрации в неоднородных пространственно искривленных нефтегазовых пластах, что основан на идеях замены реального течения в пласте некоторой близкой к нему кинематически похожей схемой движения и использовании методов комплексного анализа, в частности, разработанного численного метода квазиконформного отображения. Для случая сферического пласта построено систему ортогональных криволинейных координат (ξ , η , ζ), относительно которой получено усредненные по координате ζ уравнения для определения квазипотенциала скорости фильтрации, при соответствующих граничных условий.

Ключевые слова: многофазная фильтрация, квазиконформное отображение, численный метод.

ABSTRACTS

Labyrinth-screw pump parameters multi-criteria optimization / P. N. Andrenko, O. V. Dmitrienko, A. Y. Lebedev // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №6 (1115). – pp. 3 – 12. Bibliog.: 15 titles. – ISSN 2222-0631.

Based on the analysis of literary sources an optimization method of a labyrinth-screw pump is chosen. The methodology and the results of the multi-criteria optimization of its design and operating parameters are presented. The influence of the shape of the working bodies and the working fluid gas content on the main characteristics of the pump expressed in dimensionless values is analyzed. The data obtained allow to determine the design parameters of the pump that will ensure rational values of the power and maximum efficiency at the pump design stage.

Key words: labyrinthine-screw pump, working bodies, screw groove, multiobjective optimization, quality criteria.

Modeling the influence of preliminary dispersion in the technology of complex fertilizer / A. R. Belianskaya, N. D. Voloshin, V. V. Karmazina // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №6 (1115). – pp. 12 – 21. Bibliog.: 19 titles. – ISSN 2222-0631.

A mathematical description of activated sludge (a component of complex fertilizer) preliminary dispersion and settling process is given. The mathematical description allows to predict the degree of reduction of the residual volume of the activated sludge and takes into account the temperature of the solution, the initial moisture content of the sludge, the dispersion time and the disperser rotor speed. The parameters of the disperser rotor to be taken into account when choosing an industrial disperser are calculated. The validity of the statistical dependencies and parameters is estimated by the relative error of calculations. It is found that the dispersion of the activated sludge leads to destroying its hydrate shell, releasing the bound colloid water and intensification of the settling process. It is determined that maintaining the Reynolds number at $4,49 \cdot 10^4$, fluid vibration frequency at $533 \mathrm{s}^{-1}$, the dispersion time at $4...6$ minute, the activated sludge volume decreases from 1000 to $320 \mathrm{ml/dm}^3$. A flow chart for obtaining complex fertilizer using industrial waste, the advantage of which is increasing the useful volume of the bioreactor by increasing the concentration of the settled dispersed activated sludge, is designed.

Key words: dispersion, activated sludge, technogenic waste, complex fertilizer.

UDC 534.1: 539.3

Identification of the impulse load on a visco-elastic beam / V. T. Grishakin // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №6 (1115). – pp. 22 – 29. Bibliog.: 7 titles. – ISSN 2222-0631.

In this work the problem of identifying the position and the amplitude value of the pulse concentrated load acting on a hinged beam is solved. The solution is based on both the Kirchhoff beam model and the Timoshenko model, taking into account the energy dissipation through vibrations based on the Voigt ratios. The identification procedure involves minimizing a target function, which makes it possible to determine an approximate position of the point of the load application at the first stage of the procedure, and to calculate an approximate value of the load amplitude at its second stage. The initial data for the numerical experiment are obtained by modeling the vibrations of a beam under an impulse load by the finite element method. It is shown that the result of the load identification obtained by using the Tymoshenko model is closer to the true value than the result obtained by using the Kirchhoff model, with the accuracy acceptable for engineering practice.

Key words: identification, concentrated load, dissipation, Voigt model, minimization.

UDC 621.43.068.4

Mathematical model of the hydraulic resistance of the diesel particulate matter filter. Part 3: arrangement coefficient / A. N. Kondratenko // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №6 (1115). – pp. 29 – 40. Bibliog.: 9 titles. – ISSN 2222-0631.

The article deals with a mathematical model, which describes the hydraulic resistance of a DPF under the real operating conditions. The model is based on the flow characteristics of a single module of the filter element of DPF, obtained experimentally at a constant temperature of fluid, and the data of bench tests of an 2Ch10.5/12 autotractor diesel, equipped with a full-sized DPF. The model allows to take into account a number of factors that characterize the operating conditions of a DPF in the exhaust system of this diesel. The factors are taken into account by introducing corresponding coefficients. The dependence of these coefficients on the operating and design parameters of the 2Ch10.5/12 diesel is experimentally obtained and described by the method of linear regression. In this part of the research we describe the physical meaning and evaluate the adjusting coefficient of this mathematical model, which allows to incorporate the results of the studies on the non-motorized installation and on the engine test band, and to take into account the type of the case design of the module of the filter element of the DPF. The flow characteristics of the exhaust stream (such as the mass flow rate per unit area of the inlet section of the module) should be taken into account when choosing the model dimensions of the module and the number of the module filter element of an industrial DPF.

Key words: diesel, particulate matter filter, hydraulic resistance, mathematical model.

UDC 621.646.942

Choosing main parameters of vortex diode to prevent water hammer in vertical pipes / A. P. Kononenko, V. P. Ovsyannikov, M. V. Overko // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №6 (1115). – pp. 40 – 49. Bibliog.: 8 titles. – ISSN 2222-0631.

Powerful vertical pipes are commonly applied for mine water drainage installations. The danger of a hydraulic shock arises in them at sudden stopping of the pump. In these conditions the hydraulic diode fixed, for example, in the middle of the pipe can protect from dangerous oscillations of pressure. The most acceptable type of the diode is a jet vortex diode. The main difficulty in modeling the transition process in a vertical pipe with a jet diode is its substantial inertia. The problem was solved by introducing a local coordinate system into the calculation program for the period of the presence of the reverse fluid flow. The main parameters of the vortex diode determining its ability to effectively dampen pressure surges should be considered as the ratio of the inverse hydraulic resistance and the direct resistance, the direct hydraulic resistance and the acceleration time of the liquid (time constant). It is confirmed that the inertial properties of the diode as a whole have a negative impact on the quality of controlled transient process. It is always possible to damp the water hammer in a drainage installation by changing the direct resistance of the vortex diode; however, this will increase the unit energy cost of fluid transfer. The developed mode can be applied for determining the proportions of the rotational diode and for calculating the energy losses which can arise when using the given protection scheme.

Key words: drainage installations, protection, discharge pipe, water hammer, vortex diode.

UDC 621.65

The influence of transverse vortices on the transfer of the energy in a torque flow pump / I. V. Kryshtop, V. F. German, A. G. Gusak, L. M. Saltanova // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №6 (1115). – pp. 49 – 56. Bibliog.: 14 titles. – ISSN 2222-0631.

The article describes the influence of transverse vortices on the transfer of the energy of the liquid in a torque flow pump. The head-flow and energetic characteristic curves of these pumps for various ways of rounding the ends of the impeller blades obtained experimentally are presented. A numerical experiment for determining the flow in the channel between the blades was conducted, which allowed to precise the pattern of the flow in the pump.

Key words: torque flow pump, the transverse vortex, channel between the vanes, numerical experiment.

UDC 539.3

Analysis of geometrically nonlinear vibrations of functionally graded shallow shells by means of R-function theory / L. V. Kurpa, T. V. Shmatko // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №6 (1115). – pp. 56 – 66. Bibliog.: 10 titles. – ISSN 2222-0631.

Method based on the R-function theory for investigation of geometrically nonlinear vibrations of functionally graded shallow shells with the complex plan form is proposed. Mathematic statement is formulated in the framework of the first-order shear deformation theory. Obtained nonlinear system of differential equations with partial derivatives is reduced to nonlinear system of ordinary differential equations by several stages. Proposed algorithm is realized by means of system POLE-RL, tested on test problems and illustrated by shallow shells with complex plan form.

Key words: functionally graded materials, geometrically nonlinear vibrations, R – function theory, shallow shells with complex plan form.

UDC 519.6

Studying a method for identifying the points of discontinuity of the first kind of functions of one variable / O. N. Lytvyn, Y.I. Pershyna, V.A. Pasichnik // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №6 (1115). – pp. 67 – 76. Bibliog.: 13 titles. – ISSN 2222-0631.

In the paper a method for finding points of discontinuity and ε – discontinuity of the first kind of a linear function of one variable by interpolating the function by a discontinuous spline or approximating it by a linear spline is developed and studied. The theorems about the required number of iterations of the proposed method to achieve the required accuracy are proved. The concept of ε – continuity of functions of one variable is introduced. Base on the concept a modified algorithm for detecting discontinuities of the first kind of non-linear functions of one variable, using a discontinuous linear spline approximation is developed. An example confirming the effectiveness of the proposed method is given. The prospects for further research are also discussed.

Key words: discontinuous linear interpolation, discontinuous linear approximation, ε – discontinuity.

UDC 621.382:62-1/-9(045)

Nanocircuits with programmable characteristics / O. S. Melnik, N. V. Trokhymenko, A. O. Sobchenko // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №6 (1115). – pp. 77 – 81. Bibliog.: 3 titles. – ISSN 2222-0631.

In the paper methods for constructing arithmetic and logical computing devices of combinational and sequential types that implement a virtually complete system of logic functions in both majority and Boolean bases are proposed. An automated scheme for designing nanoelectronic circuits with programmable characteristics on quantum majority components is also implemented.

Key words: quantum automata, majority element, field-programmable gate array (FPGA).

UDC 519.71

Parametric identification of the Solow model of a macroeconomic system / O. M. Nazarenko, O. M. Nikolaienko // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №6 (1115). – pp. 82 – 91.

Bibliog.: 14 titles. – ISSN 2222-0631.

In the paper we study the problem of identification and specification of the Solow model of a macroeconomic system, in which the dependence between the investments of the economy as a whole and the releases of the sectors is linear. The phase coordinates are the fixed assets, and the controlled ones are the sector issues. The trajectories of the phase coordinates can be decomposed into trend and periodic components. The macroeconomic system is divided into sectors so that the inherent harmonic waves are tuned to the frequencies characteristic for the system. Since the trajectories of the sector issues are unknown, the differential equation of motion is satisfied at integer points of the identification period. The unknown model parameters are estimated by methods of econometrics, and the fixed assets are replaced by the gross fixed assets for which statistical information is known. The model is tested on the statistics of real macroeconomic dynamics. The econometric modeling allows to allocate significant harmonic characteristics of the system, and to restore the unknown statistical data from the fixed assets and investments. The resulting trajectories have high simulation and forecasting properties. The analysis of the harmonic waves present in the expansion of the model curves allows to determine the causes of ups and downs in the economy and to predict the future economic development.

Key words: specification, identification, cyclical process, simulation, prediction.

A mathematical model of wearing the friction surfaces of disk brake mechanisms of cars during emergency braking in an operational environment is proposed. For specific cars, the operation of the algorithm created, the results of the program, and the analysis of the results of the calculation experiment are given. Also the prospects for further research to improve the resource of disc brakes are discussed.

Key words: passenger car, disc brakes, operation.

The article deals with a dispersing device used in the hydroelectric power units for hydraulic systems, that improves the degree of purification of the working fluids. A mathematical model of the dispersing device workflow is presented. Based on the model the influence of the operating parameters on the design ones is investigated. The results of modelling the flow profile of the dispersing device allow us to formulate recommendations on the choice of its rational parameters. The mathematical model presented can be applied for modelling structurally similar devices.

Key words: dispersing device, hydraulic fluid, mathematical model, workflow, hydraulic unit.

A system of integral equations of the first kind with logarithmic kernel, which arises in a number of problems of the diffraction of waves, is studied. The sampling of the system is obtained by the method of discrete singularities. Pairs of Hilbert spaces and operators in them, corresponding to the set and discrete problems are introduced. Using them we prove the unique solvability of the discrete problem and provide a rigorous justification for estimating the rate of convergence of the solution of the discrete problem to the exact solution of the integral equations.

Key words: integral equations, logarithmic kernel, the method of discrete singularities.

UDC 631.37

Farm tractor tires identification by numeric method / A. Yu. Rebrov // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №6 (1115). – pp. 114 – 121. Bibliog.: 5 titles. – ISSN 2222-0631.

The author proposes a method for modern tractor radial tires identification using a mathematical model based on the universal characteristics of tires. The method allows to identify the tire ply rating and gross flat plate area, and to use the mathematical model for theoretical study of the efficiency of domestic and imported agricultural tractors equipped with modern radial tires, including categories IF and VF tires. For adequate simulation of radial deformation and gross flat plate area of IF and VF tires, which are characterized by high flexibility, it is proposed to adjust the mathematical model based on the universal characteristics of tires.

Key words: radial tractor pneumatic tire, universal characteristics of tires, tire ply rating, gross flat plate area.

UDC 629.113

A mathematical model for calculating the parameters of the curvilinear motion of a two section road-train turning maneuver at the design stage / V. V. Redchits, B. I. Kalchenko, E. V. Golovina // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №6 (1115). – pp. 121 – 126. Bibliog.: 3 titles. – ISSN 2222-0631.

A new method for calculating the parameters of the curvilinear motion of a two section road-train turning maneuver considering the influence of the effective deadtime of the vehicle response on the vehicle steerability but without taking into account slip angles is presented. The method is based on the modified mathematical model of single vehicle curvilinear motion. The method proposed for tracing a two section road-train allows carrying out simulation of the «turn $R_n = 35$ m» maneuver by a circular spline in the first approximation and obtaining preliminary estimates of vehicle steerability and stability at the design stage. We plan to use the method for further studying the dynamics of turning maneuvers.

Key words: curvature of the trajectory, fold angle, effective deadtime, enter into a turn, steerability, stability.

UDC 621.923

Conditions for improving accuracy and quality of machined surfaces when grinding with fixed radial force / I. A. Ryabenkov // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №6 (1115). – pp. 127 – 132. Bibliog.: 6 titles. – ISSN 2222-0631.

A mathematical model of the grinding process with a fixed radial force is developed. Based on the model the conditions for improving the accuracy and quality of machined surfaces are determined. It is proved that in contrast to grinding by a rigid scheme, the duration of processing does not actually affect the decrease in accuracy and quality of machined surfaces when grinding with a fixed radial force which is due to eliminating the friction between the grinding wheel and treated material. This is an important factor for increasing the efficiency of processing high-precision parts. When grinding with a fixed radial force the cutting temperature increases less compared to grinding by the rigid circuit.

Key words: grinding, cutting force components, power consumption of the processing, the coefficient of friction, the processing performance, the processing time, the cutting temperature.

UDC 625.282:625.032.07

Defining the parameters of an energy storage for an electrorolling stock with asynchronous traction drive under the limited current in the traction network / E. S. Ryabov // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №6 (1115). – pp. 132 – 137. Bibliog.: 5 titles. – ISSN 2222-0631.

Using an energy storage as a part of the traction drive of an electrorolling stock is considered. The expediency of using the storage in the operation mode of limited current in the traction network when it is located on the rolling stock is shown. A method for determining parameters of the storage operating in the mode of limited current in the traction network when it is used as a part of an asynchronous traction drive is proposed and analytical expressions for calculating the parameters of the drive are obtained.

Key words: asynchronous traction drive, energy storage, rolling stock, traction characteristics.

UDC 629.113+629.331

Method of determining characteristics of HEV units and operation modes for trucks depending on operating conditions / V. P. Sakhno, V. M. Polyakov, O. M. Timkov, O. S. Ivanov // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №6 (1115). – pp. 137 – 147. Bibliog.: 14 titles. – ISSN 2222-0631.

The technique developed allows to determine the influence of power distribution between the units of a HEV, control algorithm and operational route on the traction and speed properties and the fuel efficiency of trucks. The evaluation criteria are the indicators of traction and speed properties, fuel efficiency and electrical energy consumption of a truck with HEV. We use a probabilistic approach to choose the HEV rational power, its distribution between the electric motor (EM) and the internal combustion engine (ICE), and the modes of their collective work.

Key words: car, algorithm, power, motor, traction and speed properties, fuel economy, energy, route, speed.

UDC 532.5:518.5

Features of pulsing liquid jets of high speed / A. N. Semko, N. I Yagudina // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №6 (1115). – pp. 147 – 156. Bibliog.: 21 titles. – ISSN 2222-0631.

The processes in a pulse generator of liquid jets were investigated in acoustic and gas-dynamic settings. In the acoustic setting a one-dimensional problem was considered without taking into account the piston movement and the jet outflow. In the gas-dynamic setting a one-dimensional and axisymmetric problem was solved numerically with taking into account the piston movement, jet outflow and liquid cavitation. The results of calculations for different models of fluid motion were compared. The appropriate conclusions were made. It was shown that the jet velocity pulsations were related to the wave processes in the installation.

Key words: pulsing jets of liquid, liquid disks, the pulse generator of jets, cavitation, numerical modeling.

UDC 621.646.42

Improvement of the invariant method for calculating the dynamic parameters of gas in pipelines of rocket engine pneumatic starting system / S. A. Shevchenko, A. L. Grigoriev, M. S. Stepanov // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №6 (1115). – pp. 156 – 181. Bibliog.: 17 titles. – ISSN 2222-0631.

The analysis of heat-exchange processes between gas and walls of pipelines, which supply gas to the turbo pump unit, as well as control tubes of valves in the pneumatic starting system of a multiple ignition rocket engine was made. It was shown that the gas flow in the pipelines can be considered as adiabatic flow, while in the control tubes – as isothermal one. There was made an improvement of the Riemann invariants method, which allowed taking into account nonisentropic flow in the exhaust pipeline and pipeline flow resistance.

Key words: gas-dynamic calculation, continual models of pipelines; one-dimensional flow; flow resistance factor; pneumatic starting system.

UDC 629.35.02.001.57

Mathematical description of the workflow tilting mechanism truck cabs / S. N. Shuklinov, M. Yu. Zalogin // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №6 (1115). – pp. 182 – 190. Bibliog.: 8 titles. – ISSN 2222-0631.

A mathematical description of the dynamic processes of the hydraulic tilting of a truck cab is proposed. The mathematical description characterizes the dynamic processes of the cab tilting mechanism hydraulic drive with double-acting hydraulic cylinder and the displacement of the center of mass of the cab relative to the axis of rotation when it is tilted. The mathematical description of the hydraulic drive includes the equation of motion of the pump piston, the fluid motion in the pipeline, the dependencies determining the changes of pressure of the liquid at the nodes, and the equation of motion of the hydraulic cylinder rod. The equation of motion of the pump piston is presented in the form of a sinusoidal law

of a function of time and the linear frequency of the handle. The speed of the liquid in the conduit is determined from the pressure balance equation. The generalized load on the cylinder output link is determined from the differential equations of motion of a cab for a linear generalized coordinate. The equation of motion of the cab in generalized coordinates is obtained from the Lagrange equation of the second kind, describing the motion of the center of mass relative to the axis of rotation of the cab for a plane kinematic scheme of cab tilting.

Key words: mathematical description, the dynamics, cab tilt mechanism, workflow, mechanical compliance, hydraulic circuit, the operator.

Transient vibrations of a hinged plate ribbed by linear stiffeners (direct and inverse problems) / Ye. G. Yanyutin, P. A. Yegorov // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №6 (1115). – pp. 191 – 200. Bibliog.: 9 titles. – ISSN 2222-0631.

An investigation of transient vibrations of a hinged isotropic plate ribbed by linear stiffeners is presented. The solutions of the direct and inverse problems are built in terms of a mechanical system, which consists of a hinged plate and a supporting beam. The reliability of the obtained results is analyzed by comparing with the results obtained by other authors, when passing to the limit in some parameters. The comparison of the analytical solution with the solution obtained by using the finite element method is also given. The incorrectness of the formulated problems is overcome by using the Tikhonov regularization method.

Key words: plate, stiffener, Fourier series, Laplace transformation, contact condition, Volterra equation, regularization method.

A method of complex analysis and solving filtration problems in heterogeneous spatially curved oil and gas layers / S. V. Yaroschak // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №6 (1115). – pp. 200 – 206. Bibliog.: 8 titles. – ISSN 2222-0631.

A method for solving the problems of filtration in heterogeneous spatially curved oil-gas layers is developed. The method is based on the ideas of replacing the real flow in the layer by some close cinematically similar movement pattern and applying the methods of complex analysis, in particular, the numerical method of quasiconformal mapping developed by the authors. A system of orthogonal curvilinear coordinates (ξ, η, ζ) is introduced for the case of a spherical layer. Using this system we receive an averaged over the ζ coordinate equation for determining the quasipotential of filtration velocity under the appropriate boundary conditions.

Key words: multiphase filtering, quasiconformal mapping, numerical method.