

УДК 629.7.05

Обобщение трехчастотной тригонометрической кватернионной модели вращения твердого тела. Первый тип модели / Ю. А. Плаксий // Вісник НТУ «ХПІ». Серія: Математичне моделювання в техніці та технологіях. – Харків: НТУ «ХПІ», 2015. – №41 (1150). – С. 111 – 119. Бібліогр.: 6 назв. – ISSN 2222-0631.

Предложена новая непрерывная модель вращения твердого тела, основанная на обобщенном представлении модельного кватерниона ориентации в функциях углов, одновременно линейно изменяющихся во времени. Построены аналитические зависимости для квазиординат на такте вычислений параметров ориентации и компонентов кватерниона, соответствующих таким вращательным движениям. Для нескольких наборов параметров получены реализации модели. Результаты представлены в форме зависимостей квазиординат от времени и траекторий в конфигурационном пространстве для параметров ориентации. Показано, что новая модель описывает вращение твердого тела, отличное от случая регулярной прецессии. Модель может быть использована в качестве эталонной для получения оценок погрешностей алгоритмов определения ориентации в бесплатформенных системах.

Ключевые слова: кватернион, ориентация, эталонная модель, квазиординаты, траектории в конфигурационном пространстве.

УДК 621.9.06

Концептуальные принципы теории проектирования инновационных мехатронных пространственных систем приводов / С. В. Струтинский // Вісник НТУ «ХПІ». Серія: Математичне моделювання в техніці та технологіях. – Харків: НТУ «ХПІ», 2015. – №41 (1150). – С. 119 – 129. Бібліогр.: 10 назв. – ISSN 2222-0631.

Разработана концепция и основные принципы теории проектирования инновационных мехатронных пространственных систем приводов. Концепция включает разработку инновационных пространственных систем приводов на новой элементной базе. Элементная база создана на основе анализа рабочих процессов в пространственных системах приводов. Предложены основные этапы теории проектирования, которые в своей взаимосвязи позволяют разработать систему приводов пространственного типа. Системы приводов предназначены для манипулирования объектами машиностроения, в том числе в экстремальных условиях эксплуатации. Они обеспечивают работу в замкнутых объемах и перемещения объектов по стенкам. Этапы включают синтез схемных решений, расчет, макетирование, определения статических и динамических характеристик, создание элементной базы и алгоритмического обеспечения работы мехатронной системы и апробацию опытных образцов систем.

Ключевые слова: пространственные приводы, теория проектирования, синтез схем, расчет, макетирование, статика, динамика, апробация.

УДК 539.3

Развитие методики численного исследования контактной задачи плоской теории упругости / Е. Ю. Тарсис // Вісник НТУ «ХПІ». Серія: Математичне моделювання в техніці та технологіях. – Харків: НТУ «ХПІ», 2015. – №41 (1150). – С. 130 – 134. Бібліогр.: 7 назв. – ISSN 2222-0631.

В развитие методики дополнена вариационная и структурная постановка плоской контактной задачи теории упругости для однородных тел произвольной геометрической формы на основе функционала Рейсснера. Рассмотрена новая задача поиска неизвестной области контакта на участках взаимодействия упругого тела со штампами. На конкретном примере исследовано влияние боковых врезов различной конфигурации на ширину искомого области контакта.

Ключевые слова: контактная задача плоской теории упругости, функционал Рейсснера, структурная постановка, структуры для перемещений и напряжений, поиск неизвестной области контакта, штамп, опорные области, R – операции.

УДК 628.477 : 519.876.5

Математическая модель энерготехнологической установки для разделения многокомпонентных газовых смесей / Ю. В. Шахов, И. И. Петухов, В. В. Вамболь // Вісник НТУ «ХПІ». Серія: Математичне моделювання в техніці та технологіях. – Харків: НТУ «ХПІ», 2015. – №41 (1150). – С. 134 – 139. Бібліогр.: 18 назв. – ISSN 2222-0631.

Рассмотрено решение одного из проблемных вопросов, связанных с утилизацией отходов, а именно разделение многокомпонентных газовых смесей, образующихся при их газификации. Выполнено математическое описание процессов, происходящих в энерготехнологической установке разделения многокомпонентных газовых смесей, образующихся при газификации отходов, с целью получения продукции целевого назначения. В данной части исследования представлены математические модели таких функциональных элементов энерготехнологической установки, как насос, детандер и рекуперативный теплообменник. В исследовании описана модель энерготехнологической установки как единого целого, которая является исполнительной частью системы управления экологической безопасностью при утилизации отходов. Предложена методика расчета сложных энерготехнологических схем.

Ключевые слова: утилизация, отходы, экологическая безопасность, математическое моделирование, двухфазная многокомпонентная среда.

ABSTRAKTS

UDC 621.331;621.311.4

Increasing voltage quality and its regulation by PWM modulated converters on the pantograph of a train of the Ukrainian railways / V.V. Bozhko // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №41 (1150). – pp. 3 – 7. Bibliog.: 17 titles. – ISSN 2222-0631.

Modern approaches to modernization of the pantograph tension stabilization system for a 3 kW direct current electric train which moves in an area between traction substations were proposed. A simplified structure of traction power supply was presented. An algorithm for solving the problem of voltage stabilization on the pantograph of an electric train was developed and implemented in MATLAB. The MATLAB model was used to test the algorithm proposed for stabilization of the set level of voltage on the pantograph of an electric train. The oscillograms obtained are given. A direction for perfecting the system of traction power supply of 3kW direct current railways using pulse-width modulated converters as active filters, which allowed to decrease the mass of inductance of the output filter of traction substation and decrease harmonic components of both output and supply network voltages, was proposed.

Key words: contact network, traction substation, active filtering, voltage regulation.

UDC 621.735.3

Computer simulation of workpiece yielding by flat dies / J. V. Bondarenko // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №41 (1150). – pp. 8 – 11. Bibliog.: 7 titles. – ISSN 2222-0631.

Experimental studies of metal shaping in all their variety do not provide stress and strain fields, indexes compression, temperature and strain rate explicitly. Therefore, a paper on computer simulation of mold depression is of current interest. In the paper the influence of the relative reduction, temperature and speed factors on the deformation rate is investigated. The mold depression by flat dies under the influence of these three factors is simulated. Using a set of computer applications the regression coefficients are determined, the statistical significance of the regression coefficients is tested, the adequacy of the model is verified, and the optimal values of the factors in natural units are calculated. The zones of mold intense deformation are indicated. A regression modeling equation, which allows to obtain the depression force values in natural units, is derived.

Keywords: strength, workpiece yielding, simulation of compression, temperature, deformation.

UDC 389.14+658.16(075.8)

Approximation of experimental data distribution law using the beta distribution. Part 2 / S. O. Vambol', I. V. Mischenko, V. V. Vambol', A. N. Kondratenko // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №41 (1150). – pp. 11–16. Bibliog.: 14 titles. – ISSN 2222-0631.

Features of the beta distribution are investigated. The distribution application for approximating the law of distribution of the empirical data in comparison with other types of distribution laws in general and the practical use of such a distribution in the case of geometric characteristics of rolling bodies of bearings are grounded. Specialized scientific technical and reference literature, methods of mathematical statistics, probability theory, and numerical methods are analyzed. In this part of the study the Pearson curves are considered as a mathematical base of the beta distribution. The advantages of using the beta distribution to approximate the empirical law of distribution of measurement data of any kind are shown for the first time on the example of the geometric characteristics of the rolling bodies of bearings. The obtained methodology and mathematical apparatus for application of the beta distribution can be used for approximating empirical data of any kind.

Key words: errors of measuring, empirical distribution, normal distribution, beta distribution, Pearson distributions, approximation.

UDC 389.14+658.16(075.8)

Approximation of experimental data distribution law using the beta distribution. Part 3 / S. O. Vambol', I. V. Mischenko, V. V. Vambol', A. N. Kondratenko // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №41 (1150). – pp. 16–21. Bibliog.: 9 titles. – ISSN 2222-0631.

Features of the beta distribution are investigated. The distribution application for approximating the law of distribution of the empirical data in comparison with other types of distribution laws in general and the practical use of such a distribution in the case of geometric characteristics of rolling bodies of bearings are grounded. Specialized scientific technical and reference literature, methods of mathematical statistics, probability theory, and numerical methods are analyzed. In this final part of the study we define and illustrate the parameters of the beta distribution for the object of study. The advantages of using the beta distribution to approximate the empirical law of distribution of measurement data of any kind are shown for the first time on the example of the geometric characteristics of the rolling bodies of bearings. The obtained methodology and mathematical apparatus for application of the beta distribution can be used for approximating empirical data of any kind.

Key words: errors of measuring, empirical distribution, normal distribution, beta distribution, Pearson distributions, approximation.

UDC 539.3

Tikhonov's Regularization Algorithm for Ill-Posed Problems of Elastic Structural Element Nonstationary Dynamics / A. V. Voropay // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №41 (1150). – pp. 22–29. Bibliog.: 14 titles. – ISSN 2222-0631.

Tikhonov's regularization algorithm and its application to solving the ill-posed problems in deformable solid mechanics are considered. Some problems of nonstationary deforming of elastic structural elements can be reduced to the Volterra integral equations. Ill-posed problems arise in the study of the Volterra integral equations. Finite-dimensional approximation of the ill-posed problem and the smoothing functional is carried out within the bounds of the regularization algorithm. The inverse identification problem for the unknown disturbing force applied to a rectangular plate is given as an example of an ill-posed problem. The solution of this ill-posed problem is obtained using Tikhonov's regularization algorithm. Special attention is paid to choosing the regularization parameter. Functional diagrams for the regularization parameter are shown. The significant influence of the priority information on the solution of the ill-posed problems is noted in conclusion.

Key words: ill-posed problem, nonstationary loading, Volterra integral equations, smoothing functional, Tikhonov's regularization algorithm, regularization parameter.

UDC 681.5:621.914:514.85

Development of software for automating the programming of CNC devices / E. A. Glibko, I. P. Buckwheat, A. P. Minakov // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №41 (1150). – pp. 30–36. Bibliog.: 4 titles. – ISSN 2222-0631.

A program that automatically generates a control code ready to use by a machining complex is developed. It is based on the theory of computer vision to automate and speed up programming of devices with numerical control. The features of generating the control program code for roughing and finishing milling of the parts are studied. The created geometric models of the cutting process are then analyzed to precise the tool path in the direction of the altitude coordinate to prevent the unwanted cutting of the material during processing. Running the program takes much less time compared to the time which needs a programmer to create a code using the equivalent software such as Pro/Engineer or ArtCam. In this case, the machining accuracy is reduced, due to the quality of the image on the bump map. Increasing the resolution of the map slows down the program significantly. But the treatment quality is sufficient to use the developed applications for processing surfaces non-critical in the industrial sense. The results (control program) were tested in practice and are planned for implementing in the technological process of machining furniture products.

Key words: software automating, computer vision, milling, processing algorithm, control program, bump map, part model, the color and brightness of the pixels.

UDC 517.968.519.6

Mathematical model of TM-wave diffraction by ideally conducting circular cylindrical antenna with longitudinal slots filled by dielectric / S. V. Dukhopelnykov // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №41 (1150). – pp. 36–43. Bibliog.: 14 titles. – ISSN 2222-0631.

In the article mathematical models of diffraction of TM-waves by straight circular cylindrical antennas with a finite number of longitudinal slots or by circular cylindrical antennas with longitudinal slots and nested circular perfectly conducting cylinder are developed.

The problems of diffraction of TM-waves by slot antennas are reduced to singular boundary integral equations. Singular integral equations are derived for the problems of diffraction by a cylindrical ring waveguide filled with dielectric, with perfectly conducting inner surface, and perfectly conducting outer surface having longitudinal slots.

A discrete mathematical model is obtained by the method of discrete singularities and a numerical experiment is carried out on its basis. In terms of the developed mathematical models computer algorithms are built on the basis of which numerical analysis is carried out for a wide range of parameters of the structure.

The developed mathematical models allow to optimize technical characteristics of antennas and waveguides, filters and linear accelerators which is necessary for projecting and building modern radioelectronic devices.

Key words: method of discrete singularities, singular and hypersingular integral equations, slot antennas.

UDC 517.98

On an Operator of Integration / G. V. Korobskaya // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №41 (1150). – pp. 43–52. Bibliog.: 8 titles. – ISSN 2222-0631.

In this paper we study an operator, which is a linear combination of the model operator of integration and its adjoint. We prove that the operator is bounded and construct its adjoint. For the considered operator, which is not self-adjoint, a local node is determined and the node characteristic function is calculated. A semigroup generated by the operator is defined, which leads to a Cauchy problem for a second order differential equation. We note that the operator considered is not always dissipative and the operator node characteristic function possesses several features studied in the paper. The directions of further investigation are proposed.

Key words: integration operator, node, characteristic function, semigroup of operator.

UDC 517.95+518.517

The use of R-functions to define information about the building structures for the realization 3D printing / U. S. Litvinova // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №41 (1150). – pp. 52 – 58. Bibliog.: 6 titles. – ISSN 2222-0631.

The article provides an overview of information on using 3D printing capabilities for constructing projects. Applying methods of the theory of R-functions the author developed mathematical and computer models of a cottage for subsequent 3D printing. A step-by-step derivation of the equations of the structural elements of the cottage is carried out. Considerable attention is paid to the construction of the internal structures of the cottage. For convenience, several cottage roof options are implemented.

Keywords: R-function, visualization of 3D objects, constructions, 3D printing, design elements.

UDC 629.429.3:621.313

Optimization of parameters of the linear tilting motor of a vehicles / B. G. Liubarskyi, B. Kh. Yeritsyan, D. I. Iakunin, M. L. Glebova // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №41 (1150). – pp. 58 – 66. Bibliog.: 23 titles. – ISSN 2222-0631.

A simplified mathematical model of a linear motor for determining the electromagnetic force is presented. The problem of conventional optimization of geometrical parameters of a linear motor is formulated. It is proposed to use the dependence proportional to the difference of the energies transformed by the linear motor and required to move the tilting mechanism of the body as an objective function. The combined optimization method used at the preliminary search stage comprises a genetic algorithm. At the final stage of the optimization procedure the optimum is precised by the Nelder-Mead method. An algorithm for solving the optimization problem is developed and implemented in MATLAB. It is proposed to improve electromechanical tilting drives by developing a combined drive in which the total tilting angle will be created in part by an electric linear motors and in part by other mechanisms already installed on the rolling stock.

Keywords: linear motor, the conventional optimization, genetic algorithms, the angle of inclination, active material.

UDC 539.3

Direct problem of non-stationary vibrations of a system of three strings / E. S. Malakhov // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №41 (1150). – pp. 67 – 71. Bibliog.: 9 titles. – ISSN 2222-0631.

Non-stationary vibrations of a three-string system are studied. The system vibrations are caused by an external concentrated load applied at a certain point of one of the strings. The displacements of the points of the strings are described by a one-dimensional wave equation. The reactions of the strings are simulated by additional concentrated loads applied at the contact points. The Laplace integral transform is used for solving the differential equations. The problem is reduced to a system of two Volterra integral equations. The system of integral equations is solved using quadrature formulas and Tikhonov's regularization method. A computational example is given. The dependences of contact forces on time and displacements of each of the strings are obtained. The graphs of changes of contact forces and displacements in time are shown.

Key words: system of strings, transient loading, the wave equation, regularization method, Volterra integral equation.

UDC 621.452.3:536.24

Determining convective boundary conditions for a turbine using experimental data / E. V. Martsenyuk, Yu. A. Zelenyj, S. B. Reznik, R. R. Klimik, T. V. Kulik // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №41 (1150). – pp. 72 – 76. Bibliog.: 4 titles. – ISSN 2222-0631.

Convective boundary conditions for a turbine casing are determined on the basis of an aircraft engine testing. Improved accuracy in determination of the convective boundary conditions from the heat flux under complex nature of environment flow is achieved. The improvement occurred due to introduction of corrective coefficients for the heat transfer coefficients. The correction takes into account the conductive heat transfer inside the part. The identified temperature field of the turbine casing was compared with an experimentally measured one.

Key words: turbine, convection, thermal conductivity, inverse problem, heat transfer coefficient.

UDC 519.64:004.032.24

Organization and optimization of computer simulation of diffraction processes by discrete singularities method / V. O. Mishchenko, B. V. Patochkin // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №41 (1150). – pp. 76 – 85. Bibliog.: 10 titles. – ISSN 2222-0631.

In the comprehensive study of antennas and repeaters there is a need in the calculation of the parameters of diffraction of electromagnetic waves on metal screens for many forms and values of wave numbers. The time of computer modeling is critical. Using computational methods of discrete singularities, in particular the discrete currents method (DCM), becomes promising in this situation. Current reserves of improving them by using sequential algorithms are exhausted. These algorithms need to be parallelized to exploit the architectural features of modern PCs. The authors have developed a library of software components, which takes into account the important architectural features of modern PCs and allows to increase the speed of computation in several or even dozens of times. The paper shows the architecture of modeling systems for the calculations by the modified DCM, the method of preparation of primary information, the method of testing the speed efficiency and the results of such testing.

Key words: electromagnetic wave, diffraction, wave number, computer model, discrete singularities method, architecture, tiling, vector registers, OpenMP, computing speed.

UDC 517.955.8

On synchronization of oscillations of two coupled Berger plates with nonlinear interior and boundary damping. Part 2 / E. A. Naboka // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №41 (1150). – pp. 85 – 92. Bibliog.: 24 titles. – ISSN 2222-0631.

A system of Berger PDE's describing nonlinear oscillations of two identical elastically coupled plates with partially clamped and partially free boundary and nonlinear dissipation acting inside plate domain as well as on the free part of the boundary is considered. We are interested in the dependence of the structure of the system global attractor on the value of the parameter γ describing the intensity of plate coupling. In this part of our research we describe the structure of the upper limit of the attractor for $\gamma \rightarrow \infty$. We prove that it coincides with the set $diag(\tilde{\mathcal{A}} \times \tilde{\mathcal{A}})$, which is the diagonal of the product of two samples of the attractor for a single plate equation. Moreover, under additional assumptions on the damping functions the attractor for the system of two coupled plates coincides with the set $diag(\tilde{\mathcal{A}} \times \tilde{\mathcal{A}})$ for γ sufficiently large.

Keywords: coupled Berger plates, asymptotic synchronization, nonlinear dissipation, free boundary.

UDC 519.64, 539.3

Diffraction of plane harmonic waves on periodic system of cylindrical cavities / O. M. Nazarenko // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №41 (1150). – pp. 93 – 97. Bibliog.: 9 titles. – ISSN 2222-0631.

A problem of interaction of a flat longitudinal or transverse harmonic wave with a system of cylindrical cavities is studied. Integral

representations for the displacement amplitudes of the reflected field are constructed. The problem is reduced to solving a system of singular integral equations. Numerical implementation of the developed algorithms is carried out by a mechanical quadrature method. The dependences of the stresses on the boundary of the cavities on the dynamic, mechanical and geometric characteristics are given.

Keywords: diffraction, cavity, Green's function, integral equation, method of mechanical quadrature.

UDC 621.923

Mathematical model of thermal process in grinding / F. V. Novikov, O. S. Klenov, I. V. Gershikov // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №41 (1150). – pp. 97 – 102. Bibliog.: 6 titles. – ISSN 2222-0631.

A new theoretical solution to determine the temperature of cutting and the depth of penetration of heat into the surface of the workpiece during grinding considering cutting adiabatic rods, the set of which represents conventionally the removable stock, with a grinding wheel is proposed. It is shown that with the passage of the handling time the cutting temperature increases continuously approaching asymptotically a certain value and the depth of penetration of heat into the surface of the workpiece at grinding takes a finite value depending on the thermal properties of the process, in contrast to the known theoretical solutions. Let the heat source move with constant speed along an adiabatic rod. This brings the design scheme of heating during grinding to the real conditions of a grinding process and allows to approach scientifically the analysis of the thermal stress of the grinding process and to choose the optimal treatment conditions, taking into account the restrictions on the temperature of cutting.

Key words: grinding, thermal process, the temperature of cutting, adiabatic rod, time.

UDC 621.923

Analytical determination of surface roughness in the abrasive machining of holes / F. V. Novikov, R. M. Minchev // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №41 (1150). – pp. 102 – 107. Bibliog.: 7 titles. – ISSN 2222-0631.

The roughness of the surface during abrasive processing is calculated using probability theory. The patterns of changes in the surface roughness when grinding a hole are analyzed analytically. It is proved that the surface roughness is determined completely and unambiguously by the total amount of abrasive grains participating in the formation of the surface roughness of the treated surface. The advantages of honing compared to internal grinding are justified. The possibility of substantial reduction of surface roughness by using a grinding circle with the axis perpendicular to the axis of rotation of the workpiece is shown. The greatest effect is achieved when processing by the end face of a grinding wheel having circular shape and providing maximum contact area with the inner surfaces of the machined parts. To realize the proposed scheme of the internal grinding of an opening the abrasive grains must be located approximately at the same height on the working surface of the wheel. Otherwise, cutting will involve only the most protruding grains which will lead to the formation of individual scratches on the treated surface and will not let to reduce substantially the surface roughness.

Key words: abrasive machining, grinding, honing, hole, surface roughness.

UDC 629.4.027.11: 681.518.5

Model of the pre-failure condition of axle boxes of rolling stock / V. M. Petukhov // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №41 (1150). – pp. 107 – 111. Bibliog.: 12 titles. – ISSN 2222-0631.

The conducted research shows that integrated control systems are used for axle equipment of modern rolling stock. Such systems increase the adequacy of technical condition estimation and are capable of detecting faults early and predicting remaining life. It is also shown that not all the axle equipment having high temperature is faulty. The greatest risk of error in determining the axle equipment technical condition appears in the so-called "ambiguity area" because it is impossible to estimate its technical condition exactly. To estimate the axle equipment technical condition in the ambiguity area, a model in the form of an n – dimensional radius vector having a trend to increase the probability of failure and to worsen parameter values is proposed. The model developed for determining the pre-failure condition will contribute to decreasing the probability of making wrong decisions as to the train operation mode. It will influence the train operation safety and stability of transportation process.

Key words: axle box unit, control of technical condition, a built-in control, ambiguity area, pre-failure condition, radius vector.

UDC 629.7.05

Generalization of a three-frequency trigonometrical quaternion model of a rigid body rotation. First type of model / Yu. A. Plakhsy // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №41 (1150). – pp. 111 – 119. Bibliog.: 6 titles. – ISSN 2222-0631.

A new continuous rigid body rotation model based on a general concept of the model quaternion of orientation as functions of the angles simultaneously linearly changing in time is proposed. Analytical dependences for the quasicordinates on a step of calculations of the parameters of orientation and for the components of the quaternion corresponding to such rotations are constructed. Realizations of the model for several sets of the parameters are obtained. The results are presented in the form of the dependences of the quasicordinates on time and trajectories in the configuration space for the orientation parameters. It is shown that the new model describes the rotation of a rigid body other than the case of regular precession. The model can be used as a reference model for estimating errors of orientation algorithms in strapdown inertial navigation systems.

Key words: quaternion, orientation, reference model, quasicordinates, trajectories in configuration space.

UDC 621.9.06

Conceptual principles of design theory innovative spatial mechatronic drive systems / S. V. Strutinsky // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №41 (1150). – pp. 119 – 129. Bibliog.: 10 titles. – ISSN 2222-0631.

The concept and basic principles of the theory of designing innovative mechatronic spatial drive systems were developed. The concept includes the development of innovative spatial drive systems built on a new element base. The element base was developed by analyzing the processes in spatial drive systems. The basic stages of the design theory, which in their correlations make it possible to develop a spatial drive system, were proposed. The drive systems are designed to manipulate objects in machine building, including operating in extreme working conditions. They can work in confined spaces, and move objects on the vertical walls. The stages include circuit design synthesis, calculation, modeling, determining static and dynamic characteristics, creation of the component base and algorithmic support of the mechatronic system operation, and system prototypes testing.

Keywords: spatial drives, design theory, circuit synthesis, calculation, modeling, statics, dynamics, approbation.

UDC 539.3

On the development of numerical study of a problem of plane elasticity / Ye. Yu. Tarsis // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №41 (1150). – pp. 130 – 134. Bibliog.: 7 titles. – ISSN 2222-0631.

In the paper a method for solving planar contact elasticity problems using Reissner functional is developed. The method is adapted for solving a new problem of determining unknown contact areas on the sites of interaction of an elastic body and dies. The unknown contact areas were previously determined for the coupling cases only, whereas the contact areas under the dies were assumed to remain unchanged. The problem is supplemented by appropriate boundary conditions and structures. To illustrate the method applications a specific problem is considered. It is shown that the areas of the contact of the body with the dies differ depending on the geometrical characteristics of the body side faces. Outside these areas the body separates

from the dies.

Key words: contact problem of plane elasticity, Reissner functional, structural setting, structures for replacements and stresses, determining of an unknown contact area, die, bearing areas, R – operations.

UDC 628.477 : 519.876.5

Mathematical model of energy-technological plant for the separation of multicomponent gas mixtures / Yu. V. Shakhov, I. I. Petukhov, V. V. Vambol // Bulletin of National Technical University «KhPI» Series: Mathematical modeling in engineering and technologies. – Kharkiv: NTU «KhPI», 2015. – №41 (1150). – pp. 134 – 139. Bibliog.: 18 titles. – ISSN 2222-0631.

The general subject of our current research is the problem of accumulation and utilization of municipal hazardous solid waste of industrial and anthropogenic origin. In particular, in the present paper we solve one of the problematic issues related to utilization of waste, namely the separation of multicomponent gas mixtures produced during their gasification. The processes taking place in the energy-technological plant for separation of multicomponent gas mixtures produced during gasification of waste products in order to obtain useful products is described mathematically. In this part of the study we present mathematical models of complex assemblies such as a pump, an expander, and a recuperative heat exchanger. The study describes a model of the plant as a whole and as an executive part of an ecological safety management system of the waste utilization process. A method for computing complex energy technological schemes is proposed.

Key words: utilization, biowaste products, ecological safety, dioxins, mathematical modeling, dispersion multiphase structure.