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SUMMARY and KEYWORDS

MECHANICAL AND THEORETICAL ENGINEERING

D. I. Chernyavsky, D. D. Chernyavsky
Kinematic calculation of micromirror elements in microelectromechanical systems (MEMS)

Currently, the development and application of micro machines is an important direction in the development of microelectromechanical systems (MEMS) technologies. In these devices, electromechanical energy conversion occurs, as a result of which forces arise that carry out mechanical work within the dimensions of the microcircuit case. The paper considers the kinematic calculation of the design of a micromirror with a reflective layer of high optical quality of the surface for deflecting the reflected laser beam. By changing the angle of inclination of the micromirror, the laser beam enters the various input channels of the optical sensor. In this case, a control signal is generated for the further operation of the microcircuit. Thus, the micromirror performs the function of a switch of input optical channels, connecting in various combinations certain input or output elements of the microcircuit for further processing. The article presents the calculation of the kinematic parameters of the mechanical structure of the micro mirror. Practical recommendations are given for choosing the optimal range of variation of the micro mirror tilt angles in order to increase the strength of its structure, as well as to reduce the power of the mechanical drive of the micro machine required to change the micro mirror tilt angles.

Keywords: microtechnology, microelectromechanical systems (MEMS), microoptoelectromechanical devices (MOEMS), similarity theory, energy conservation law, mechanical drive of micromirrors, kinematics, mechanical strength.

V. A. Ilyinykh
Application of conical profile spindle-mandrel joints in multi-purpose machines

The article deals with the solution of the problem of improving the quality of torque transmission connections of spindle units of multi-purpose machines. The aim of the work is to determine the contact stiffness of the spindle-mandrel joints of various types, based on the conducted simulation experiments of the assembly and disassembly process of auxiliary tools of various structural forms, in conditions of reusable replacements.A comparative analysis of the mathematical expectations of contact stiffness of traditional and non-traditional conical profile split joints based on an equiaxial contour with a number of faces equal to three under external loading conditions is performed. The results obtained allow us to predict the quality indicators of multi-purpose machines in the design of quick-release connections.

Keywords: conical profile split joints with equiaxed contour, multi-purpose machines, auxiliary tools (mandrels), spindle assembly, contact stiffness, assembly process, reusable replacements.

Komkov, S. A. Gubar, G. G. Voskresensky
Alloying working surface during electroslag surfacing

Parts subject to intense abrasive wear have a short service life. In the manufacture or restoration of such parts by electroslag surfacing, strengthening of the deposited metal is required. The use of ready-made alloying powders in surfacing increases the cost of the finished part, which necessitates the search for cheaper materials for alloying the parts being welded. The study of the efficiency of alloying the deposited metal through the melted insert, as well as by direct introduction of alloying powders into the slag bath has been carried out. Mixtures based on enriched mineral scheelite concentrate and graphite are used as alloying powders.

Keywords: alloying, electroslag surfacing, scheelite oal-thermal reduction.

M. A. Jasem, P. Y. Krauinsh
The mathematical model of engagement and analytical description of tooth profile of waveform edge kinematic reducer

The problem of creating a waveform edge kinematical reducer with multi-pair gearing brings to the fore a range of issues in the field of geometric-kinematic gearing theory, which are considered in this work. The synthesis of multi-pair gearing for a waveform edge kinematical reducer, which ensures the constancy of their transfer function, provides for: development of a mathematical model of gearing taking into account the peculiarities of the interaction of teeth during special-spherical motion; description of the profile of the teeth by a system of equations for a spherical surface and for a normal section of teeth for internal gearing; identification with the help of the MathCAD 2010 Professional program of a mathematical experiment and determination of the area of existence of 100 % multi-pair mating of teeth by comparing the shape of their profile with the nature of the analytical function of multi-pair engagement.

Keywords: multi-pair gearing, space-spherical motion, waveform edge kinematical reducer, tooth profile, gear ratio.

ELECTRICAL ENGINEERING

A. A. Tatevosyan
Scientific basis for design low-speed synchronous permanent magnet generators for wind power plants

In this paper, the scientific basis for designing wind power plants (WPP) with low-speed synchronous generators on permanent magnets (SGPM) is understood as a system of scientific knowledge that forms the theoretical basis for the practice of designing a complex object, such as WPP consisting of interconnected equipment and structures designed to convert wind energy into electrical energy. Currently, the development of advanced WPP designs is receiving increased attention around the world. For example, in the Russian Federation, a promising direction is the creation of Autonomous WPP with low-speed medium- and low- power SGPMs that have the maximum range of applications by type of activity and climate zones throughout the territory. However, engineering approaches to the design of individual components of the WPP indicate the difficulties of developing a scientifically based methodology for optimizing the parameters of the WPP as a whole taking into account the mutual influence of individual components on each other. At the same time, the methodology for optimizing the parameters of WPP is understood as a tool for the scientific basis of design, which takes into account quality indicators and optimality criteria, energy and technical characteristics, as well as design stages with the results of preliminary and verification calculations. For the stage of verification calculations of VEU parameters, the scientific basis of design is determined by the construction of mathematical models and their research using application software packages for PCs, while for the stage of preliminary calculations, the development of analytical methods of analysis is important. This article discusses the scientific basis for designingwind turbines at the stage of preliminary calculations, formulated the problem of optimizing the parameters of low-speed WPP, proposed equations for the relationship of design parameters with the energy performance of wind turbines, providing the maximum efficiency of synchronous generators, taking into account the specified technical conditions.

Keywords: problem optimization of WPP parameters, low- speed synchronous generator, cylindrical magnetic core, permanent magnets.

N. A. Serebryakov
Application of adaptive ensemble neural network method for short-term load forecasting electrical engineering complex of regional electric grid

The article is devoted to the problem of improving the accuracy of short-term load forecasting of electrical engineering complex of regional electric grid with the use deep machine learning tools. The effectiveness of the application of the adaptive learning algorithm for deep neural networks for short-term load forecasting of this electrical complex has been investigated. The issues of application of

convolutional and recurrent neural networks for short-term load forecasting are considered. A comparative analysis of the accuracy of the short-term load forecasting of electrical engineering complex of regional electric grid obtained using the ensemble neural network method and single neural networks are produced.

Keywords: regional electric grid, forecasting electricity consumption, artificial neural network, learning algorithm, convolution networks, recurrent neural networks.

I. V. Komarov,D. A. Polyakov,K. I. Nikitin,V. Yu. Miroshnik
Mathematical model of insulation breakdown prediction based on partial discharge characteristics

The paper investigates the existing mathematical models of insulation destruction. It has been determined that most of the models for assessing the residual life of insulation are based on models of thermal and thermo-oxidative destruction of insulation materials. Currently, solid dielectrics are gaining popularity, including cross- linked polyethylene, PVC, ethylene-propylene rubber, and others. In such dielectrics, it is possible to estimate the residual life in the short term. This possibility and necessity is due to the possibility of growth of tree defects under the influence of partial discharges. The article describes the proposed mathematical model for assessing the residual resource of insulation by modeling the growth of a defect. To take into account the influence of random variables, the model uses the Weibull distribution. The model assumes the division of the insulation thickness into some areas, each of which is destroyed independently of the others. The destruction of these areas occurs when partial discharges occur with certain energy sufficient to destroy the material. Insulation failure is predicted using the least squares method. The results obtained can be useful in assessing the residual life of insulating materials and in conducting research in this area.

Keywords: insulation breakdown, insulation defect, partial discharge, insulation destruction model, breakdown prediction.

Yu. V. Plotnikov
Power supply for monitoring and metering devices of DC traction network based on serial chain of voltage converters

When designing devices for monitoring and accounting of electric energy for railway traction networks of direct current, one of the main tasks is to create a source for their power supply. The paper considers the problems that arise when using power sources from the network of own needs of a traction substation, reviews the main technical solutions of sources powered from the traction network, and also offers an original solution that has a high efficiency compared to its prototype.

Keywords: power supply, traction network, monitoring device, metering device, high input voltage.

INSTRUMENT ENGINEERING, METROLOGY AND INFORMATION MEASURING EQUIPMENT AND SYSTEMS

V. I. Guzhov, I. O. Marchenko, E. E. Trubilina, A. A. Trubilin
Sampling signals with finite set of apertures

The article discusses the issue of sampling continuous signals using a finite set of apertures. Using the apparatus of generalized functions, an analytical form of sampling is obtained for ideal sampling, for sampling a limited signal and for sampling a signal using a limited set of apertures. It is shown that the signal spectrum is the product of the signal spectrum at ideal sampling by some known factor, the influence of which can be eliminated. The type of this factor can be obtained if the type of aperture is known. The type of analytical expression differs from those known in the literature on image sampling.The use of an analytical expression for sampling can beused to reconstruct the original image from the image obtained with different sets of apertures. For this it is necessary to divide the Fourier spectrum of the sampled image by a factor depending on the selected aperture. Having received the inverse Fourier transform from it, you can get the original one.

Keywords: ideal discretization, Dirac lattice, discretizationin real systems, generalized functions, Fourier transform, spectrum.

D. P. Sedunov, A. S. Zhunusova
Development of algorithm for receiving and decoding input signal using MTD decoder for subscriber terminals operating with low-orbit spacecraft

The relevance of the topic is determined by the need to increase the speed of data transmission in satellite telecommunication systems through the use of noise-proof coding. The speed of data transmission in a radio channel is actually determined by the level of interference present due to the fact that the radio transmission medium is a public environment and other electronic devices operate in it. The purpose of the article is to develop an algorithm for encoding and decoding the input signal using a multi-threshold decoder (MTD) of rigid solutions for subscriber terminals operating with low-orbit spacecraft (NCA), and its comparison with a conventional PC decoder «Messi». The comparison allows us to conclude that the application of the developed algorithm is justified in systems where more stringent requirements are imposed on the probability of an error in the communication channel, while the «Messi» decoder is more appropriate to use in the presence of restrictions on computational complexity.

Keywords: Reed-Solomon codes, multithreshold decoders, satellite telecommunications systems, low-orbit spacecraft, «Messi» decoder, average transmission error rate, marker signal.

A. D. Mekhtiyev, A. I. Soldatov, Ye. G. Neshina, A. D. Alkina
Fiber optic control system for geotechnical parameters of mine

In the article a fiber-optic method for monitoring rock pressure is considered, as well as the magnitude of the displacement of the layers of the stope hanging wall is measured. The authors analyze the applied rock pressure testing methods. The reasons for the need to create a safe system are given, the main requirement of which is the condition of compliance with all safety requirements during mining operations. The developed quasi-distributed fiber-optic system is capable of measuring with high accuracy changes in rock pressure and displacement of roof rocks in an explosive environment, also does not require expensive equipment associated with the use of a range of analyzers and reflectometers. A scheme has been proposed to simplify the testing process. The results of dependences of additional optical losses on the applied force are obtained.

Keywords: optical fiber, sensor, sensor, deformation, mine displacement.