MECHANICAL AND THEORETICAL ENGINEERING

P. D. Balakin
Determination of motion of mechanical system with non-holonomic constraints

It is shown that mechanical systems with self-organizing behavior can be created with the use of multi-mobility non-holonomic constraints in them. For the solvability of mathematical models of the motion of systems with non-holonomic constraints, we propose a separate simulation of the motion along them.

Keywords: multi-mobile non-holonomic links, built-in control circuits of the kinematic system.

A. P. Bolshthyanskiy, V. E. Scherba, V. I. Surikov, V. S. Kalekin, G. S. Averyanov,
G. A. Nesterenko, A. A. Gladenko
Hydraulic systems for independent cooling of low-flow piston compressors

The article deals with various schemes of Autonomous liquid cooling of cylinder piston groups of low-flow piston compressors, which are used to organize the movement of the coolant moving parts of the cylinder group and pressure fluctuations in the discharge and suction lines of the compressor. The advantages and disadvantages of each scheme are analyzed.

Keywords: power engineering, mechanical engineering, hydraulics, pneumatics, pump, compressor, repair, service.

B. A. Kalashnikov, V. I. Kuznetsov, A. B. Yakovlev
The exhaust device of ground energy plants with swirling of gas flow

Questions of the increase of efficiency of power plants, namely internal combustion engines are considered. The urgency of application of various vortex devices for increase in power, productivity, increase of efficiency and decrease in toxicity of products of combustion of these engines is proved. An overview of the work on improving the efficiency of engines shows the advantages and disadvantages of the previously proposed methods. An exhaust device for an internal combustion engine is presented, which allows to increase the power and reduce the specific fuel consumption. The results presented in this paper are useful for creating new and improving existing devices to improve the efficiency of power plants.

Keywords: internal combustion engine, engine effectiveness, exhaust pipe, twisting flow stream, ejection.

S. N. Litunov, V. N. Stepanov, H. A. Hilal, T. F. Matar
On the model of ink flow in printing apparatus of stencil machine

It is proposed to use the printed stencil apparatus of increased accuracy, containing a metering and cylindrical squeegees. To determine the optimal pressure in the ink under the action of a dosing squeegee, it is necessary to develop a mathematical model that includes the flow past the plate by the translational fluid flow. At the first stage of the simulation, the circle is mapped to an ellipse with the help of the Zhukovsky transformation, the rotation and shift of the ellipse, and the pair of plates arranged symmetrically to the horizontal axis.

A. A. Novikov, D. A. Negrov, A. R. Putintseva, V. Yu. Putintsev
Method of estimation of duration of operation of ultrasonic technological tools

A method for estimating the duration of operation of ultrasonic technological tools is proposed, a relationship between the mechanical properties of the material and the operating mode of the ultrasonic instrument is found. This method of determining the service life of the tool allows you to estimate the time of tool change, as well as increase the duration of the waveguide operation.

**V. E. Scherba, A. P. Bolshthyanskiy, V. I. Surikov, G. S. Averyanov, V. S. Kalekin,
S. A. Korneyev, E. Yu. Rodionov**
Experimental study of autonomous systems of liquid cooling of the piston compressor

The article describes experimental studies to determine the effect of the two variants of the hydraulic autonomous cooling system on the temperature of the cylinder-piston group using pressure fluctuations in the suction cavity of the piston low-flow compressor. A comparison with a conventional external cooling system using atmospheric air flow is presented. It is shown that the use of automatic control of air flow resistance in the suction has a positive effect on reducing the temperature of the cylinder.

I. A. Sysuev, S. N. Litunov, N. N. Kozina, I. V. Lukyanova, A. A. Miroshnichenko
Assessment of perception of electronic publications, made on white and colored backgrounds (qualimetric aspect)

The article deals with the issues related to the creation of an attractive appearance of regular pages of electronic publications including texts with black font characters located on different colored backgrounds. The relevance of the topic is due to the need for an objective assessment of the typographic design of electronic publications (qualimetric aspect). The purpose of the work is to determine the effect of the background color on the text of the electronic publication on the perception of the graphic image of the page, taking into account its (graphic image) contrast. Data related to the perception of the graphic image of pages with different contrast are presented. The perception of electronic publications made on white and four color backgrounds is evaluated. The connection between the rank of expert evaluation and the contrast of the graphic image of the pages, including the background color, is analyzed. Conclusions: for electronic publications, traditionally made: the black color of the font characters is a white substrate, the positive perception is determined by the high contrast of the graphic image of the page. For publications with black font characters placed on different colored backgrounds, this relation also takes place, but is not usually used.

ELECTRICAL ENGINEERING. POWER ENGINEERING

V. P. Dovgun, D. E. Egorov, I. G. Vazhenina, A. F. Sinyagovskiy
Adjustable harmonic filters for traction supply systems

Problems of design for controlled filtering and compensation systems (FCS) for railway AC traction systems are considered in this paper. The proposed FCS ensures discrete reactive power compensation by switching of filter section. A broadband 3–5 order passive filters (BBF) are used as a commutated sections.
A general BBF design procedure, based on performance optimization in the space of reactive elements parameters, is developed.
The proposed filtering system provides reactive power compensation and harmonic mitigation in wide frequency band. The effectiveness of proposed solution has been confirmed by computer simulation.

Keywords: railway traction systems, harmonics, reactive power compensation.

V. M. Lebedev, V. K. Gaak, A. Yu. Finichenko, S. V. Prikhodko
The state and main directions of regional heat power engineering development in Siberian conditions

The article considers the state and main directions in regional heat power engineering development with reference to Siberian conditions. It is noted that in many Russian cities the heat supply schemes have not been corrected. It does not give preference to the combined production of electrical and thermal energy. There is no evaluation of the renewal of morally and physically worn out equipment. The structure of the hierarchical construction of heat supply systems for municipal, industrial heat and power engineering in joint work with heat sources (CHPP) of the power system is not being developed. The work on the use of solid fuel and its combustion in fluidized bed furnaces, rational use of natural gas and the organization of gas superstructures is not actively carried out.

Keywords: heat supply system, combined power generation, fluidized bed furnaces, gas superstructures, equipment renewal, combined-cycle plant, investment, low-power cogeneration plant.

A. A. Bubenchikov, T. V. Bubenchikova, O. V. Kropotin, G. S. Smorodin, E. Yu. Shepeleva, E. A. Manakova, A. A. Zakharov
Flow accelerator tower type for wind power plant

In the article six-blade designs of an air stream accelerator of a simplified type are considered. The aim of this work is to study and select the optimal design of a tower-type wind power plant. With the help of software and experimental research, the geometry of the channel is determined and the design is chosen with the increase in the speed of the passing stream in 2,75 times, acceleration of the oncoming flow by 55 % and the increase in power produced by wind power plants in 3 times. These results make it possible to judge the expediency of studying the problem of increasing the speed of the air flow to increase the output of the units.

Keywords: an air flow accelerator, a wind turbine with a tower type accelerator, optimized concentrator design.

A. A. Bubenchikov, T. V. Bubenchikova, K. V. Khatsevskiy, G. S. Smorodin, E. A. Manakova, A. A. Pogorelov, I. A. Gaibov
Investigation of spiral flow accelerators for wind turbines with vertical axis of rotation for electric power systems

The article analyzes the application of the simplest designs of air stream accelerators to identify the most promising geometry for research. The best geometry of a multilobed structure is determined for its application as a flow accelerator for wind power plants with a vertical axis of rotation. The maximum acceleration of the flow and the possible increase in the power produced by the wind power plant are determined. The achieved speed increase is 52 %. Since the power depends on the wind speed in the cube, this design will allow increasing the power produced by the windmill in three times.

Keywords: flow accelerators for wind power plants, spiral flow accelerators, wind energy concentration.

T. A. Novozhilov, A. N. Novozhilov, E. M. Volgina
Field of use of magnetic current transformers in electric power industry

Traditionally, current transformers are used to measure current in elements of electric power systems and construct relay protection for these elements. However, the main disadvantage of current transformers is the restriction on the installation caused by the need for tie-in to the measured circuit where the conductor has considerable dimensions, over which large currents pass. This drawback is devoid of magnetic current transformers of various types. In the paper, the features of the construction of the current conductors of various industrial enterprises are considered and recommendations are offered on the choice of the location of the magnetic current transformers on these current conductors.

Keywords: Relay protection, current protection, current conductors, magnetic current transformers.

T. A. Novozhilov, A. N. Novozhilov, A. O. Yusupova
Simulation of electrical capacitance of measuring transducer

The modern circulating electrical machines used to produce electric power and act as drivers are wide spread in electric-power industry.
One of typical mechanical troubles electrical machines encounter is rotor eccentricity. It leads to non-uniformity of air gap between stator and rotor and formation of additional magnetic fields in it which affects electromechanical features of electrical machines. In its turn, this results in electric power loss and when the eccentricity rises the stator and rotor core can overheat and the coil can damage. This can lead to total damage of the machine. Nowadays, rotor eccentricity can be determined by using methods based on measuring values which are caused by additional magnetic fields. However, the sensitivity of the methods mentioned is limited by the need of considering the interferences due to variation of mains settings and loads. In this sense, capacitive sensors used as measuring capacitive transducers are known to be more perspective diagnostic means for determination of rotor eccentricity.
The current document features a simple method for calculation of a capacitive transducer with electrodes of various shapes. This method comprises modeling the transducer electro-statical field using nets method and calculation of capacitance based on the empirical formula proposed. As an example, the method efficacy is checked by determination of plate capacitor capacitance using the

method proposed and classical formula. It is demonstrated that the modeling accuracy didn't exceed 5 %.

The example included modeling a capacitance for electrodes with toothed rotor of electrical machines and with different positions of capacitive transducer plates – above rotor slot opening and above the middle point of rotor tooth of electrical machines. This document also contains the appropriate calculation details and capacitance calculation in both positions. As a result, it is proven that the method proposed provides a simple and quite accurate modeling and calculation of capacitive transducer capacitance with various electrode shapes.

D. S. Osipov, N. N. Dolgikh, D. S. Satpaev, E. G. Andreeva
Analysis of single-phase earth fault mode in networks with combined neutral ground by means of wavelet transformation

The paper presents the technique for two stage identification of a line where the fault took places. Timely detection of the line with single phase ground fault increases reliability of power supply and reduces risks of defeat of personnel electric current.

The first stage is based on the analysis of high frequency components arising under transients. The second stage involves an analysis of the steady-state mode of a single phase-to-ground fault. Based on the energy spectrum of higher harmonics a damaged line is detected. The proposed method can be implemented to organize digital protection against ground faults.

V. L. Fedorov
The criterion for determining number of harmonics of finite Fourier series approximating voltages and currents of transformer

The results of measurements of the transformer voltages and currents are often approximated by Fourier series. The accuracy of the approximation depends on the number of retained harmonics. The criterion for determining the number of harmonics of a finite Fourier series is proposed in the article. The correlation coefficient between measurements (in the form of digital data arrays) and their approximation by a finite Fourier series is equal to one. The resulting approximation relative error estimation does not exceed 0,31 %. The working capacity of the criterion in the ranges of variation of the Total Harmonic Distortion for current (3,27…70,97) % and the voltage (0,19 ... 9,29) % is shown. It is established that a decrease in the current correlation coefficient to 0,996...0,947 (with a decrease in the number of harmonics in comparison with the calculated one) leads to an increase in the estimation of the relative error of approximation to (8,27...29,65) %. The proposed criterion can be used: a) in the study of periodic steady-state processes in the transformer both in idling mode and under load; b) to determine the dynamic magnetic properties of soft magnetic materials.

A. V. Ded, Yu. P. Lavrikov, V. N. Goryunov, O. V. Kropotin, , P. S. Smirnov
Determination of admissible ranges of slow changes of tension in the center of power supply

Results of imitating modeling of slow changes of tension in points of final connection of electric equipment are presented in the article, at regulation of level of tension in the center of food of 6/0,4 kV. In the environment of a Simulink (Matlab) package, the model where tension level in the center of power supply has been created and tension level in characteristic points on clips of electroreceivers of consumers is fixed. The temporary charts of tension received as a result of natural tests on the party of 6 kV of transformer are accepted to basic data. By results of modeling admissible borders of change of levels of tension for observance of requirements to the level of deviations of tension at consumers are defined.

Keywords: quality of electric energy, deviation of voltage, asymmetry, quality characteristics, quality control of electric energy.

D. V. Kovalenko, P. S. Smirnov
Accounting the influence of higher harmonics in calculating the power and energy losses arising in the cable power line when connecting to network of group of personal computers

In this paper, physical measurements of the electrical energy quality indicators (SCE) for an electrical network feeding the computer class of one of the educational institutions of the city of Omsk are made. Based on the data obtained during the experiment, the amplitude-frequency spectrum of the harmonics is determined. It is established that PCEs are violated when PCs work, which in some cases go beyond GOST 32144–2013. The calculation of the losses of power and active energy appearing in the cable power line in the presence of higher harmonics in the network is made. Losses are determined for each of the harmonics separately, and total losses. It is shown that the losses arising at the frequencies of the higher harmonics should be taken into account in the calculations. The installation of higher harmonic filters is proposed to improve the PCE (so that they comply with the requirements of GOST 32144–2013).

Keywords: electric power quality indicators, higher harmonics, power and energy losses, non-sinusoidal non-stationary mode.

**INSTRUMENT ENGINEERING, METROLOGY
AND INFORMATION MEASURING EQUIPMENT AND SYSTEMS**

Yu. M. Veshkurtsev
New generation modem for future data transmission systems. Part 2

The noise immunity of the modem in the channel with noise is theoretically investigated. Statistical modeling of the modem is carried out and it is established that the modem with characteristic modulation of a signal works without errors at data transmission on the channel with noises at the ratio signal/noise unit and less.

Keywords: characteristic modulation, the noise immunity of the modem, estimation, characteristic function, error probability, signal to noise ratio, noise immunity.

I. A. Kirovskaya, A. V. Yureva, P. E. Nor, R. V. Ekkert, L. V. Kolesnikov, Yu. I. Matyash, S. A. Korneyev

The impurity and phase composition of surfaces of semiconductors of the type$A^{III}B^{V}$ – materials for gas sensors

The chemical composition of the initial and variously treated surfaces of semiconductors of the type $A^{III}B^{V}$ – GaAs, InB^{V} (InAs, InSb, InP) is comprehensively investigated.

Initial surfaces contain mainly adsorbed molecules of H_2O, CO, CO_2, oxygen, hydrogen, traces of carbon and its hydrogen compounds, oxide phase.

There are suggestions about the composition of the oxide phase: it consists mainly of the oxides of atoms A^{III}.

After heat vacuum treatment ($T = 673$ K, $p \approx 1{,}33 \cdot 10^{-4}$ Pa) semiconductor surfaces are almost completely free from adsorbed impurities and largely from the oxide phase. The residual oxide phase does not shield the active surface involved in adsorption-catalytic processes.

The violation of stoichiometry, especially noticeable after thermal vacuum treatment, due to the removal of atoms in B^{V} with the formation of their vacancies is shown.

The increased activity of the surfaces of the semiconductors studied in relation to gases of a certain electronic nature, due to the presence of vacancies (vacancy defects) and the residual oxide phase is the basis to recommend them as materials for the corresponding sensor sensors.

Keywords: $A^{III}B^{V}$ semiconductors, IR spectroscopic, mass spectrometric, quantum chemical studies, impurity and phase composition of surfaces, sensors.

I. A. Kirovskaya, A. V. Yureva, A. O. Ekkert, I. Yu. Umansky, L. V. Kolesnikov, Yu. I. Matyash, S. A. Korneyev

Investigation of surface activity of semiconductors of the type $A^{III}B^{V}$. Possibilities of their use in sensor technology

Based on the results of studies performed by methods of hydrolytic adsorption, mechanochemistry, IR spectroscopy, and quantum chemistry, the changes in the surface activity of semiconductors of the type $A^{III}B^{V}$ (GaAs, InAs, InSb, InP) exposed in air, thermovacuumed, mechanochemically dispersed in water, isopropyl alcohol.

The weakly acid nature of the initial surfaces is shown, for which predominantly coordination-unsaturated atoms are responsible, the increased activity of freshly formed surfaces; A number of intermediate compounds appeared on real (partially hydrated) surfaces of semiconductors, as well as under water adsorption, adsorption and catalytic decomposition of isopropyl alcohol. The enrichment of freshly formed surfaces by coordination-unsaturated atoms and their clear determining role as active centers during the adsorption of molecules such as NH_3, H_2O, iso-C_3H_7OH, as well as certain regularities in the change in surface activity are established. Practical recommendations on the use of the studied semiconductors as materials (active elements) of gas sensor sensors are given.

Keywords: semiconductors, freshly formed surface, IR spectra, mechanochemistry, acid-base properties of surfaces, sensors-sensors.

R. B. Burlakov
Simple way of evaluation of thickness of nanometer transparent film SiO in process of its thermally vacuum precipitating

Modified simple way of the evaluation of the thickness an nanometer transparent film SiO in the process of its thermally vacuum precipitating are considered. For the evaluation of the thickness of the film on the working substrate is used interference colouration of the transparent film, simultaneously precipitated on the checking substrate, situated on vastly smaller distance from the small vaporizer, in contrast with the distance from the small vaporizer before the working substrate. Using of this way allows simplifying a technology of the fabrication of nanometer transparent films.

O. V. Krivozubov, Yu. G. Kryazhev, N. A. Davletkildeev, D. V. Sokolov, V. A. Likholobov
Making nanostructured layers of conjugated polymers from dehydrochlorinated polyvinyl chloride

There is investigated the possibility of making thin layers of organic semiconductors based on conjugated polymers, synthesis from polyvinyl chloride dehydrochlorinated under the action of aniline in dimethylsulfoxide. Polyvinylene layers have made by deposition on glass substrate of stable colloidal solutions polyvinylens from system polyvinyl chloride-aniline-dimethylsulfoxide by three methods: spin-coating; shower with gradient drying; deposition on the water surface and then transfer films on a substrate. Formed nanostructured coatings have thickness from 30 to 400 nm and contain nanoscale structure of different configurations, in particular, discs the thickness of 30×50 nm with laterals sizes 250×550 nm or solid smooth layers with sizes up to several micrometers, thickness 100 nm. Deposited polyvinylen layers have properties typical for organic semiconductors.

A. V. Nikonov, V. A. Nikonov, R. N. Bogatov
Methodology of applying and implementing provisions of discrete recursive model for self-adjusting adaptive control systems for production appointment

An approach is shown that allows building a self-adjusting adaptive control system. The intelligent controller sets the optimum system parameters depending on the operating mode, the properties of the control object and the destabilizing factors. For the application of the system as part of a comprehensive automated control system, the company proposed to use the concept of «foggy computing in a foggy network».

M. V. Trenikhin, I. V. Anikeeva, Yu. G. Kryazhev
Producing carbon-carbon layers by laser irradiation of a polyvinyl chloride film containing carbon nanoparticles additives

The possibility of using laser radiation for carrying out structural transformations in polyvinyl chloride films modified by additions of nanoglobular carbon with diameter of particles 50–70 nm is shown. Under the influence of laser radiation is observed ordering of graphene layers of carbon

globules by the formation of nanocapsules with a diameter of 5–20 nm. At the same time, carbon is enriched in the polymer phase due to the dehydrochlorination of polyvinyl chloride. The results of scanning electron microscopy and energy dispersive spectroscopy indicate that these structural transformations occur only in the near-surface region of a film not more than a few microns thick, with the formation of composite structures in which conglomerates of carbon nanocapsules are embedded in an amorphous carbon matrix. Interest in such materials is due to the fact that they combine the useful properties of the carbon matrix with a unique complex of electrophysical and optical properties characteristic for carbon nanoparticle.

Keywords: laser radiation, polyvinyl chloride, carbon, carbon nanoparticles, nanocomposite, electron microscopy.

A. A. Kabanov
Development of analog filtering circuit for electromyography signal

Filtering biophysical signals, such as electromyography signals very important task for the designer, who designs the biophysical signals acquisition systems. Many factors influence on the signal during acquisition process. Receiving the real signal proceeds in big noise quantity conditions. For receiving the real electromyography signal, it is necessary to delete the noise components from the signal. Filtering circuit for the EMG signal is developed and simulated in Filter Pro Desktop program. The resulting circuit responds the requirements. It allows to delete the noise from movement artifacts and signal instability.

Keywords: electromyography, noise, signal, active filter, butterworth filter, monitoring, multi-loop feedback.

Yu. N. Klikushin, V. A. Komarov, A. A. Fedotov, A. V. Shiler
Virtual filter model

The operation principle and structure of the virtual device model intended for detection, isolation and classification of periodic signals in a mixture with random noise are considered. The model uses an adaptive algorithm for controlling the number of averaging cycles, which automatically guarantees obtaining a given error in waveform reconstruction for low signal-to-noise ratio.

Keywords: adaptive algorithm, noise, identification tester, periodic signal, filter, distribution form.

INFORMATION TECHNOLOGY

V. I. Potapov
Development of models for research of reliability of information system restored after refusals with architecture «client-server»

Two mathematical models for the description of behavior of an information system with architecture «client server» without account and taking into account final reliability of the control system and restoration of the refused component of the considered system are constructed. The behavior of an information system in the presence of refusals and maintenance of components is approximated by Markov process and described by the system of the differential equations with variable coefficients.

The solution of the received differential equations by numerical methods on computers allows to conduct a research of various characteristics of reliability of information «client server» systems in the wide range of change of intensity of refusals and restoration of components of the system.

I. M. Zuga, V. G. Khomchenko, A. N. Kuzhel, A. O. Stroev
Simulation model for optimization of production facilities arrangement on varied terrain at single-level arrangement of horizontal part of utilities

Criterial and object function is proposed in order to minimize costs for utilities relation implementation between production facilities considering such facilities arrangement on varied terrain. Utilities and cable external wiring are provided in three sections: first and third are vertical and second (middle) is horizontal. It is accepted that horizontal part of utilities is arranged on one common for all facilities level: either on predetermined or on the level determined during optimization search. Additional conditions for synthesis are considered by penalty function introduction. Numerical example is provided hereof.

A. N. Florensov
About models of homeostatic systems on the basis of differential equations with stochastic parameters

It is offered to describe dynamics of society not by traditional methods of completely determined or stochastic model, and to use mathematical model of the differential equations with stochastic changeable basic parameters. The constructed four-component model of society corresponds to the homeostatic system of the third type. The analysis shows that a part of such natural systems allows the description the models which are integrally combining properties of the determined and stochastic systems. Internal management and homeostasis give the interactions between system components determined on functional communications in dynamics, and the stochastics arises as result of influence of elementary interactions between simpler components of system.

A. O. Stroev, I. M. Zuga, V. G. Khomchenko, A. N. Kuzhel
External wirings computer aided design interface diagrams between industrial buildings and facilities

Communication interface between the developer of master plot plans of industrial facilities and a package of applied programs for the automated design of external wiring diagrams between buildings and facilities is proposed. The developed set of interface windows ensures the integration of this software package with the previously proposed system for automated design of location schemes for industrial facilities, functioning in the mode of its continuation, and, in addition, provides the opportunity to create new projects. The interface allows you to input initial data and extract design results in a convenient format, presenting them in a tabular and graphical form. It is open, allowing for an extension in terms of the use of various methods of designing and optimizing routes diagrams.