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## SUMMARY

## ENGINEERING SCIENCE

V. Yu. Yurkov

**Mathematical modeling of linear monoidal hypersurfaces**

This paper is devoted to the problem of multidimensional linear hypersurfaces considered as models of some technological processes. The hypersurfaces have two properties: monoidality and linearity. The method of model parameter calculation is proposed.

Keywords: hypersurface, linearity, hyperplane of parallelism, mathematical models.

V. Yu. Yurkov

**Mathematical modeling of complex piecewise hypersurfaces**

The conditions of complex piecewise hypersurface modeling is considered. The piecewise hypersurfaces have topological equivalence with complexes. Each piece has topological equivalence with hypercube or simplex. The method is a generalization of multidimensional nonlinear piecewise interpolation.

Keywords: hypersurface, hypercube, simplex, correspondence, mathematical models.

P. D. Balakin, E. A. Dyundik, O. S. Dyundik

**Modeling of behavior of mechanical transfer with built-in chain of management**

The circuit solution of design and algorithm of dynamic research of behavior of mechanical autovariator, with function of stabilization of components of power of a power stream at variable external loading is proposed.

Keywords: autovariator, chain of management, generalized coordinate, transfer function.

V. N. Blinov, V. V. Kositsin, E. B. Charushina, V. V. Shalay  
**The efficiency increase directions of ammonia electrothermal microengine with tubular heating elements**

On the basis of experience of creation of the electrothermal microengine (ETME) with tubular element the directions of thrust specific impulse increase and improvement design and technological solutions of ammonia ETME due to modernization of the ETME design scheme are proposed.

Keywords: ammonia, tightness, thermocouple, thrust specific impulse, electrothermal microengine.

V. R. Vedruchenko, V. V. Kraynov, E. S. Lazarev

**About walls deformation in cylindrical oil tanks for boiler plants and other liquid fuel consumers**

The operational details of tanks for storing oils from petrol mineral oil on boiler plants, tank farms and storages are reviewed. To reduce operating costs, metal consumption and costs on tanks building it is expedient to design and build them with reasonable strong size. The computational method is proposed for designing cylindrical oil and other liquid fuel containers by using walls deformation calculations.

Keywords: oil tanks, strong size, using safety, computational method of walls deformation.

E. N. Eremin, A. Sh. Syzdykova, V. M. Yurov, S. A. Guchenko  
**Study of multielements ionic-plasmic coating obtained by while sputtering cathodes in argon**

The paper presents experimental results on the structure and properties of ion-plasma coatings obtained while spraying a composite cathode

alloy Al-Cu-Si and a cathode made of steel 12X18H10T. The coatings are deposited in argon to the substrate of steel 45. The structure of steel coatings is studied by optical, electron and atomic force microscopy. It is found that coatings 12X18H10T + Al - Cu - Si, resulting in an argon atmosphere have a columnar structure characteristic of single-phase films. The mean value of microhardness of the coating is 364 MPa with an average value of microhardness bases substrate 256 MPa. The difference is a more than 1,4 times. It is shown that the microhardness of the coating defines nanostructures carbides and intermetallic coatings main alloying elements.

It has been established that the increase in microhardness of coating and reducing the coefficient of friction result in increased operating characteristics of the steel parts 45.

Keywords: ionic-plasmic sputtering, structural steels, multi-phase coating, structure, microhardness, wear resistance.

E. N. Eremin, A. Sh. Syzdykova, V. M. Yurov  
**Structure and properties of the ionic-plasmic coatings obtained by while sputtering cathodes 12X18H10T and Ti**

The paper presents experimental results on the structure and properties of ionic-plasmic coatings obtained while spraying a titanium cathode and cathode steel 12X18H10T. Coatings are deposited in nitrogen and argon on substrate 45. It shows that 12X18H10T + Ti coating in the atmosphere of nitrogen gas and argon has a columnar structure characteristic of single-phase films. Covering 12X18H10T + Ti in a gaseous environment of nitrogen has nanohardness equal to 35.808 GPa and argon - 3.339 GPa. The difference obtained by 10 times. It is found that the coating of steel 12X18H10T + Ti, obtained in a nitrogen gas atmosphere containing 73 % Ti, and the coating 12X18H10T + Ti, obtained in an argon gas atmosphere has a high content of Fe - 64,96 %. Experimental results indicate that the nanohardness 12X18H10T + Ti coating in the atmosphere of nitrogen determined nanoscale titanium nitride whose dimensions lie within the range 5 - 10 nm.

Keywords: ionic-plasmic sputtering, structural steels, multi-phase coating, x-ray analysis, electronic microscopy, microstructure, nanostructure, microhardness, nanohardness.

V. S. Kushner, D. S. Gubin

**Determination of field of rational modes of milling nickel based super-alloys face mills using temperature dimensional stability**

In the article the technique of theoretical definition of rational modes of milling nickel alloys is considered. As the main limitations of the bond wear rate with temperature dimensional stability of the cutting blade. The calculation of the temperature is carried out taking into account the relationship of temperature and resistance characteristics of nickel alloys plastic deformation, as well as taking into account the influence of heat flows vents from the cutting zone in the tool and the workpiece.

Keywords: rational modes of milling, nickel based super-alloys, yield point, heat flux, deformation temperature, plastic deformation.

V. S. Kushner, O. Yu. Burgonova, D. S. Gubin

**The effect of temperature on strength in area of plastic contact on the front surface during cutting**

The hypotheses about specific tangential forces on the anterior surface during cutting is considered. Based on available experimental and theoretical data on the influence of strain rate and temperature on the resistance to plastic deformation the effect of hardening and softening of the material in the plastic zone of contact of chips with the tool is obtained. The theoretical results are compared with experimental data. The proposed equations approximating dependence of shear strength on temperature during cutting. The results can be used to calculate forces and cutting temperatures.

Keywords: unit shear force, temperature, strain rate, strengthening, weakening, approximation, extrapolation.

**V. V. Syrkin, V. A. Treyer**  
**Elements of calculation of pressure regulator of increased tightness**

Elements are considered for calculating the parameters of the hydraulic pressure regulator original design, which has a higher integrity. The obtained dependences allow to determine the velocity of the fluid flow in the inlet channel controller depending on the pressure regulator shutoff element and flow area of mentioned channel.

Keywords: flow and pressure, hydraulic fluid regulator, flow speed, the force of spring tension, change in the amount of fluid flow.

**V. G. Khomchenko**  
**Using the method of virtual rotation for solving the inverse problem of kinematics in manipulators of platform type**

The method for solving the inverse problem of kinematics of manipulators of the parallel structure is suggested in the article. This method based on the virtual rotation methodology and provides the simplification of the calculation algorithm.

Keywords: manipulators of the parallel structure, inverse problem of kinematics, virtual rotation.

**V. G. Tsyss, I. M. Strovok, M. Yu. Sergaeva**  
**The rubber-metal shock-absorber fatigue resource analysis taking into account the temperature model influence of the operation**

The work purpose is to estimate the measure accumulation of the rubber-metal shock-absorber damages using the package of the finite-element analysis ANSYS. It is carried out the rubber-metal shock-absorber fatigue resource analysis allowed to define summarize degree of its damage taking into account the temperature influence of the operation.

Keywords: rubber-metal shock-absorber, damage accumulation, fatigue resource, operation temperature model, stress-deformation condition.

**E. S. Gebel, A. A. Abdiraimov, E. V. Solonin**  
**Kinematics of spatial four-link slide mechanisms**

In the article, we deal with the spatial four-link mechanisms that are more preferred due to its compact scheme and the possibility of transmission of motion between the arbitrarily located axes in space. Solution of the direct kinematics problem is based on the well-known principles of analytic algebra, geometry and trigonometry. Simulation of mechanisms is proved the adequacy of the proposed methods and is provided to form recommendations on the choice of free parameters of synthesis to avoid «dead» positions.

Keywords: spatial mechanism, four-link mechanism, kinematics, simulation.

**V. A. Konovalov, A. S. Glukharev, A. I. Grechushnikov**  
**Parameter estimation of thick-walled tube forming pieces crimped conical matrices in the absence of radial deformation of the inner surface of not crimped portion of workpiece**

In the article the results of research of thick-walled tube billet forming matrices with conical funnel in 150, 200 and 250 and crimping from 1,2 to 1,5 for the schema when in the not crimped portion of workpiece is placed mandrel to remove the possibility of metal flow in this zone in the direction of the axis of a workpiece. Quantitative data can help you to simulate the shape and size of forgings with specified initial workpiece and tool options.

Keywords: crimp, matrix, heavy-gauge taper pipe.

**An. A. Krutko, Al. A. Krutko, A. A. Vorobyev, D. A. Potakhov**  
**Optimization of form of cutting tool for turning of railway wheels on the basis of durability assessment under temperature and force application**

There is taken into account the changes physical-mechanical properties of tool material under the action of the temperature field and the various laws of distribution of loads on the contact surfaces of the tool, which not only leads to elastic and plastic deformation of the solid alloy. There is developed optimal geometry of the cutting tool, which provides the lowest voltage in the body of the cutting tool at the turning of the railway wheels taking into account the temperature and force effects.

Keywords: railway wheel, the cutting tool, temperature, stresses, margin of safety.

**A. A. Krutko, V. I. Fisenko, A. A. Vorobyev, D. A. Potakhov**  
**Assessment of the intense deformed state and durability of the cutting tool when turning railway wheels**

There is used numerical method of calculation of the stress state of the cutting carbide tools with regard to hardening chamfer and different

values of the angle of its front surface. It is investigated static strength of the cutting tool during the machining of the railway wheels of varying hardness taking into account the force effects.

Keywords: wheelset, the cutting tool, hardness, stresses, margin of safety.

**O. S. Lomova, A. P. Morgunov**  
**Control of geometric precision cylindrical grinding machines by ultrasound**

The paper results of research on the control of geometric precision cylindrical grinding machines. It is experimentally proved alignment of the centers of area of the support surface in the center hole by the ultrasonic method. Ultrasonic testing and analytical dependences of the skew angle of the axes of the centers from changes in the supporting surface and the amplitude of ultrasonic vibrations allow, if necessary, adjustment of the machine.

Keywords: cylindrical grinding machine, center, center hole, the ultrasound, the bearing surface.

**B. E. Lopaev, R. R. Khismatulin, I. I. Kagarmenov, A. M. Ustyan**  
**Evaluation of weldability of steels of different classes by chemical carbon equivalent**

On the basis of the calculation of the chemical equivalent of the estimation of carbon tendency of carbon and alloyed steels to the formation of cold cracks, relating to the notion of «weldability of materials» is obtained.

Keywords: elemental carbon equivalent, weldability, cold crack, martensite, the local concentration, incubation period.

**Yu. P. Makushev, L. Yu. Volkova**  
**Choice of effective section through passage dispersers and differential characteristic of injection of fuel for diesels with a cylinder power up to 250 kW**

The calculation procedure and nomograms for a choice of the effective section through passage of dispersers of spray jets for diesels are given by various cylinder power. The chart allowing depending on fuel pressure in the accumulator and time of injection is offered to define cyclic giving at single-phase and multiphase injections.

Keywords: disperser, effective section through passage, nozzle bores, differential characteristic of injection.

**G. N. Mitrakov, S. N. Evdokimov, E. G. Lavrik, V. S. Sazonov**  
**The use of additive technologies for casting burned models**

The article describes the characteristic features of the development of manufacturing technology of casting burned models (CBM) manufactured by additive technologies (3D-printing). It is shown that the previously conducted thermal analysis during heating in the temperature range LPM technology, models samples grown on different 3D technologies, allows you to evaluate the possibility of rational use of these models for LPM, and also contributes to the selection of well-known or development of new technological methods, recommendations for technology optimization at all stages of manufacturing castings.

Keywords: the casting burned models (CBM), additive manufacturing (AT), «growing», 3D printing of objects, thermal decomposition.

**G. N. Mitrakov, V. S. Sazonov, A. V. Polyakova, I. S. Anikin**  
**Improving the efficiency of investment casting using additive technologies**

The article considers the possibility of increasing the use of precision casting, investment casting (IC) as the result of application of additive technologies, to significantly reduce the time of preparation of production and improve the quality of castings at IC, through the use of 3d printing non-metallic materials in the manufacturing process tooling.

Keywords: investment casting (IC), additive manufacturing (AT), «growing», 3D printing of the objects.

**N. A. Raykovskiy, A. V. Tretyakov, S. A. Abramov, V. V. Potapov, D. V. Zulin, A. V. Vetlugin**  
**Experimental research of process of heat-eliminating medium flowing in sickle-shaped gap of oil-free bearing**

This work presents a procedure for experimental research of turbine's oil-free slide bearing and test bench for its implementation. During testing visualized water's flow, as well as the dependence of the pressure loss from flow different heat-eliminating medium for sickle-shaped gap at different frequencies of rotation of the rotor.

Keywords: oil-free bearing, cooling system, experimental procedure, process of heat-eliminating medium flowing.

**D. S. Rechenko, A. Yu. Popov, E. V. Leontyeva, M. G. Matveeva**  
**Creation of hard-alloy tool for superfast grinding of superfinishing cutting processing**

The quality of sharpening of a hard-alloy cutting tool defines its firmness, quality and reliability of cutting processing. Today there is a large number of companies delivering the metal-cutting tool to Russia. The nomenclature of the provided tool is various and includes a cutting tool for high-precision processing, thus, quality of sharpening of the edge, that is the radius of rounding of an edge of this tool makes an order 10–15 microns, that in turn allows to make processing with shaving thickness at least 20–30 microns. This restriction often is critical and limit as the accuracy of processing of some key details makes 3 ... 5 microns, and also leads to the considerable lowering of a potential resource of a cutting tool. Improvement of quality of sharpening to values 1–3 microns allows to receive high accuracy of processing and a resource of a cutting tool that also positively is reflected in quality of processing. This work is performed with financial support of the Ministry of Education and Science of the Russian Federation.

Keywords: metal working, high speed grinding, sharpening of the hard-alloy tool.

**A. V. Chernyakov, K. V. Pavlyuchenko, V. S. Koval, D. N. Algazin**  
**The study of the grain separator with inclined air channel by planned experiment**

The article investigates the grain separator with an inclined air channel by the planned experiment. There are obtained the dependences of the quality characteristics of the separator on the completeness of separation. There are identified significant and insignificant factors affecting the operation of the separator.

Keywords: grain cleaning, separation, air flow, channel angle of inclination.

**S. V. Belokopytov, A. D. Gedz, A. V. Kolunin, S. A. Gelver, A. B. Markov**  
**Changes in temperature of oil and coolant at engine warming Kamaz-740.30.260 at low temperatures**

In this paper, the dynamics of changes in temperature liquids engine systems KAMAZ-740.30.260 KAMAZ-5350 family of Mustang in the process of warming up. Start the engine is carried out in winter conditions at ambient temperature – 32 °C without the use of pre-heater PKP-30, but with the use of electric-heating the air (EPF). The typical dependence of temperature change of coolant and engine oil is shown. It establishes during warm engine running on the recommended instruction manual rotation of the crankshaft of the engine before the vehicle ready for use under load.

Keywords: low temperature, warming up, the crankshaft speed, temperature sensor, operation.

**S. V. Belokopytov, A. V. Kolunin, A. I. Blesman, D. A. Polonyankin**  
**The technique of watered engine oil sludge research**

The article considers the influence of engine oil watering on its sludge formation. The technique of qualitative and quantitative elemental composition of the engine oil sludge with the 1% water intrusion is developed. The elemental composition and its distribution in the engine oil sludge is studied.

Keywords: engine oil, oil watered, sludge, scanning electron microscopy, elemental composition.

**I. A. Bugay, E. V. Vasilev, A. Yu. Popov**  
**Technology of sharpening front surface shaped broaches for processing difficult materials**

For machining of turbine engines made from hard materials there is used expensive and time-consuming tool - broaching. Thus, in this paper, on the basis of the research, a method of extending the lifetime of multiple tip of the cutting tool is presented. Restoring the cutting ability of cutting tools by grinding and changes in the geometric parameters is proved. Number of regrinding drawing increased the number of +1–2 calibrating teeth.

Keywords: drawing, re-sharpening of broaches, grinding wheel dressing, cutting power restoration.

**V. V. Kolb**  
**Experimental research of way of reduction of transient time in diesel engine**

The article is devoted to the experimental research of possibility of improvement of operational indicators of the forced diesel engines by application of the offered scheme of the increase of mobility.

Keywords: piston engine, ways of regulation, air supply, a turbo compressor, pressurization, a diesel engine.

**V. G. Martynov**  
**Imitating modeling of machine-assembling production by means of Petri's networks**

Management of modern assembly manufacture is complicated task. In the view of importance of the accepted solutions rather urgent the application of methods of mathematical and computer modeling is represented. The purpose of research is creation of the advanced mathematical model of an assembly site for operative management of working hours with line assembly of products. The scientific novelty consists in maintenance of modeling of assembly of several units simultaneously or line assembly.

Keywords: assembly of details, technological process, industrial site.

**P. V. Nazarov, E. V. Vasylev, A. Yu. Popov**  
**Design of construction of special device for grinding wheel dressing**

The article analyzes existing tools for dressing shaped surfaces, analyzed existing schemes shaped abrasive wheel changes and developed a special device for the chosen method of dressing.

Keywords: grinding wheel dressing, tools for wheel dressing, profile grinding, abrasive tools, shaping accuracy.

**M. S. Peshko, P. M. Shkapov**  
**Adaptive system intelligent control of process parameters in food industry**

This paper considers the adaptive intelligent control of process parameters developed using fuzzy logic. There is considered the formulation of the research problem, solution method and the results of industrial research system.

Keywords: intelligent control system, technological process, object control, fuzzy regulator, rule base.

**I. A. Teterina**  
**The results of experimental studies of the system of vibration protection of road sweeping machine on the basis of MTZ-80**

Results of experimental tests of vibroprotective system of a road sweeper machine on the basis of the MTZ-80 tractor for different operating modes of the machine are reflected in the article. Values are presented and the comparative analysis of mean square values of the corrected vibration acceleration on the DVS case, a cab floor and sitting of the operator of a road harvest sweeper-collector when cleaning the territory from snow with use of the sweeping equipment is given.

Keywords: vibration, vibration acceleration, vibration protection, road sweeper machine.

**S. N. Litunov, M. V. Batishcheva, V. V. Skitchenko, O. E. Serdyuk**  
**Features paste filling holes in the blanks LTCC-chips**

Ways of filling paste small diameter holes in the blanks used in the manufacture of chips for LTCC-technology. It is proposed instead of the traditional technologies for these products fill the holes to use screen printing using a roller. The algorithm of the calculation and the results of computational experiments show the use of the roller.

Keywords: screen printing, LTCC-technology, viscous liquid.

**S. N. Litunov, Yu. D. Toshchakova, V. V. Skitchenko, O. E. Serdyuk**  
**Non-Newtonian fluid flow in asymmetric flow**

We investigated the hypothesis of the existence of quasi-solid body in the flow of thixotropic fluid in the flow of a given shape. A theoretical study of the viscous fluid is done. Studies are performed using computing and natural experiments. The experiments confirmed the hypothesis of the existence of quasi-solid body of asymmetric flow thixotropic liquid.

Keywords: ideal liquid, viscous liquid, quasi-solid body model of the flow of a viscous fluid.

**I. A. Sysuev, I. V. Prud, E. A. Derzhavina, M. V. Vdovina**  
**On the development of a test object of average Russian text: determining the saturation of a single character text set**

The article describes a software-based method of determining the saturation of a text set in electronic and print publications. The authors consider the possibility of upgrading the method to ensure universalization of its use with respect to Russian texts and review the development of an appropriate test object.

Keywords: text set, the saturation of a text set, software-based method of determining the saturation of the text set of electronic and print publications, universal test object.

**I. A. Sysuev, I. V. Prud, E. A. Derzhavina, M. V. Vdovina**  
**The use of a test object of an average Russian text to determine the saturation of a text set of electronic and print publications**

The article deals with a software-based method of determining the saturation of a text set of electronic and print publications. It considers the possibility of upgrading the method to ensure the universalization of its use with respect to Russian texts by employing a special test object. A method of forming a universal test object is introduced.

Keywords: text set, the saturation of a text set, software-based method of determining the saturation of a text set of electronic and print publications, universal test object.

**V. R. Bedruchenko, V. V. Kraynov, E. C. Flek**  
**Optimization of heavy liquid fuel preparation for burning in furnaces of boilers and other fuel burning installations**

In the article directions of development of fuel preparation methods of heavy liquid fuels of oil origin for efficient combustion in boiler furnaces, stoves, and other fuel combustion installations are examined. There is created a comprehensive requirements for physical-chemical, energy and environmental properties of heavy fuels. There is proposed the list of measures for optimal preparation of the called fuel for efficient combustion.

Keywords: fuel oil, preparation of fuel, optimization, energy and environmental properties, combustion products, emulsification, bubbling.

**K. I. Nikitin, M. Ya. Kletsel, K. S. Taronov**  
**Reserve current directed protection with memory for lines with branches**

The improved variant of reserve protection of lines is able to disconnect short circuits (SC) after the transformers of branches at the smallest currents of SC is examined, and it does not to work superfluously due to the entered blocking.

Keywords: line, with branches, short circuit protection, the sensitivity, the current difference.

**P. G. Petrov**  
**Work brushes with Teflon coating on commutator machines**

This article presents the results of experimental studies of innovative work brushes with Teflon coating on the collectors of DC machines, there has been some improvement in terms of switching, with some observations revealed the technology plan.

Keywords: brush, switching, sparking area, collector, Teflon, the current-voltage characteristic.

**E. A. Tretyakov**  
**Regulation of the parameters in the system mode power supply not-traction consumers on railways**

As you know, energy efficiency of power supply system of railways can be achieved on the basis of measurements of informative parameters and implementation of coherent control actions on the actuators regulators providing specified reliability, power quality and the level of losses in real time. Solution of the complex issues associated with the regulation of the parameters re-benching in the electricity system not traction consumers railways to improve the efficiency and reliability of the transmission and distribution of electricity, it is very important. Proposed and implemented on the model predictive control methods regimes in power supply system not traction consumers railways provide increased reliability, quality of electric energy and reduce losses.

Keywords: power supply system, not traction consumers, regulators of lation mode setting, coordination of control actions, intelligent controller.

**I. A. Yanvaryov, V. Yu. Grokhotov, M. V. Grokhotova**  
**The increase of efficiency of utilization heat transfer equipment of heat power installations at use of stage-by-stage heat exchange**

The effective utilization of fuel and energy resources at operation of heat power installations is important and actual. At the industrial enterprises using gas turbine technologies application of utilization heat transfer equipment will allow to achieve essential economy of fuel natural gas. The complex decision of problems arising at it can be achieved on a way of application of stage-by-stage process of heat exchange.

Keywords: heat power installation, utilization heat transfer equipment, stage-by-stage heat exchange, economy of fuel and energy.

**A. I. Antonov, Yu. M. Denchik, D. A. Zubanov, A. A. Ruppel**  
**The procedure for processing results of experimental studies on compliance voltage deviation requirements GOST 32144-2013**

There is described tests on JSC «Plant of fasteners». It describes a method of processing the results of experimental studies of quality of electric

energy by means of software in the development environment LabVIEW. The analysis of the consistency of slow voltage variations is done on each phase portion of the enterprise requirements of GOST 32144-2013.

Keywords: power quality, voltage fluctuation, electromagnetic interference, waveform voltage, statistical data processing.

**N. S. Lupov**  
**Operating principle of ejector**

This paper describes the principle of operation of the ejector classical scheme. The rationale of energy exchange between the gas flows in the ejector due to viscous forces is presented. It illustrates the inadvisability of describing the operating principle ejector from the standpoint ideal liquid.

Keywords: ejector, gas flows, energy transfer, viscous forces.

**D. D. Ondar**  
**Calculation of solar energy resources of the Republic of Tyva**

In this article, it is proposed a method of calculation of solar energy resources and the results of calculation of solar energy resources for the Republic of Tyva, using meteorological data within 22 years.

Keywords: solar energy, gross solar energy potential, technical potential of solar energy, the economic potential of solar energy.

**M. S. Sherstobitov, E. M. Rezanov, V. M. Lebedev**  
**Determination of optimum temperature of heating of air necessary for burning of the burning-up fuel in waste incineration boiler units**

The algorithm of determination of optimum temperature of heating of the air for burning of the burning-up fuel in waste incineration boiler units proceeding from a minimum of the total discounted costs of an air heater and the burning-up fuel is offered. Expediency of application of the developed algorithm allows to cut a specific consumption of the burning-up fuel, to increase efficiency of waste incineration units is proved.

Keywords: efficiency, expenses, thermal energy, a heat transfer, the burning-up fuel, the package boiler.

**A. I. Odinets, L. D. Fedorova**  
**MEMS sensors for controlling and diagnosing vehicle**

There is formulated some suggestions related to micro electromechanical system sensors that allow them to diagnose vehicles. Digital processing provides the necessary information: optimization of combustion processes (fuel efficiency), safety while driving.

Keywords: MEMS sensors.

**D. B. Martemyanov, V. V. Pshenichnikova, S. K. Krutko**  
**Shortcomings of technique for checking thermoelectric converters and ways of its elimination**

For the modern industry the increasing value gets the accuracy of measurements on which the success of all production depends. Temperature indicators play an important role in such spheres as the oil and gas industry, nuclear power, housing and communal services and many others. Today this parameter can be taken quite precisely by means of thermoelectric converters temperatures. However, over time the accuracy of thermocouples can decrease. For prevention of it, from time to time devices have to pass time calibration.

Keywords: thermoelectric transducer, thermocouple, calibration.

**D. B. Martemyanov, V. V. Pshenichnikova, D. A. Shabanov**  
**Development and evaluation of methods of test for type approval of RTD**

Today, around the world for measurements of temperature in pipelines of heat supply the platinum thermometers of resistance of classes A and B possessing stabler characteristics, than used earlier copper and nickel are used. Platinum thermometers have a smaller error in comparison with copper and nickel one (from 0,25 to 0,8 °C) and wider working range of temperatures. Again there is developed a sample of thermo-converter of resistance of TSP 9201 exposed to pilot studies. The main achievements in the field of research of the created model is entering in the State register of measuring instruments (registration No. 13587-01.)

Keywords: temperature, thermometers of resistance, tests.

**V. V. Bokhan, S. A. Grakov, V. A. Taran, A. V. Zubarev**  
**Frequency response of flexible reticulate-plate panel fragments: the experimental study of eight specimen**

The paper presents the results of experimental study of the eight flexible reticulate-plate panel fragments of size 2-by-1 plates. It is noted that

the position of the peak point of frequency response curve is changing from one measurement to another. A statistical analysis of the results of observations is performed.

Keywords: flexible reticulate-plate panel, method of forced resonant oscillations, frequency response.

**A. P. Averchenko, B. D. Zhenatov**  
**Evaluation of win computational cost Hartley transform to Fourier transform.**

The article is devoted to the calculation of gain in speed by the method of Hartley with respect to the Fourier method, that is approximately 36 %. Due to the absence of complex numbers in the calculations and allows you to use less high-speed microcontrollers thereby reducing costs in the development of communication systems.

Keywords: FFT, FFH, basis Hartley, Fourier basis.

**A. O. Lozhnikov, A. N. Lepetaev**  
**Investigations of TD cut resonators with B-mode reduction**

The main disadvantage of TD and SC-cut resonators is the low resistance of B – mode, making it difficult to use in some cases. The paper deals with the methods of suppressing of unwanted modes, based on the special constructions of excitation electrodes, and the results of experiments to study the properties of such resonators. It is shown that a small change in the traditional design of the electrodes allows improve the resistance ratio more than three times without deterioration the fundamental mode.

Keywords: TD-cut resonator, B-mode, C-mode, crystal resonators, double rotated cut, temperature mode reduction.

**V. I. Potapov, O. A. Gorn**  
**Mathematical models and computer software system for implementation of optimal control problems confronting the moving and fixed objects**

Task and developed a mathematical model of confrontation between the two redundant technical systems are involved in a conflict situation. A software package for the numerical solution of the problem on the computer is reduced to a differential game between rival mobile and stationary objects and moving objects.

Keywords: mathematical model, confrontation, moving objects, stationary objects, differential game software package.

**L. F. Nemirova, S. B. Kataeva**  
**Optimization of the choice of materials for models and collections of clothes**

In this paper we consider the problem of optimal choice of materials for clothing collections using models and methods of discrete optimization. We give a mathematical formulation of the problem, which is a generalization of the well-known set covering problem. The principles of formation of collections of clothes with a certain visual variety is given.

Keywords: design, visual variety, choice of materials, the collection; graph theory, integer linear programming.

**E. B. Yudin, V. N. Zadorozhnyi**  
**The calculation of the number of network motifs by carcasses random sampling**

The development of efficient algorithms for the analysis of network motifs is a direction in Network Science, which is of great importance in the study of communication networks, social, biological and other networks. Detection and calculation of number of network motifs are closely related to the counting of typical isomorphic subgraphs in large graphs. In the article the method of random carcasses sampling is developed based on the Monte Carlo method. The method is used for the acceleration of the calculation. Examples of counting of typical subgraphs with 3 and 4 vertices in the undirected graph are given. The proposed approach can also be extended to analysis of directed graphs.

Keywords: network motifs, algorithm analysis, subgraph counting.

**A. N. Gromov, A. P. Tiunov, M. S. Fomenko, V. G. Shahov**  
**Modeling information security based on multi-dimensional arrays**

The authors propose an algorithm for analysis and modeling of information security based on previously proposed by game models. The variants of the description of the security, including the dynamic component, as well as options for quantitative evaluation are presented.

Keywords: information security, game matrix, weighting function, route, path of the optimal route.

**A. V. Leonov**  
**The Internet of Things — security challenges**

The research on security increasingly causes the attention of academia. This work analyzes in depth three key security requirements: authentication, confidentiality, and access control, with a special focus on IoT systems. And this paper is mainly underlined that security issues are not completely solved until now. In succession, different approaches recently been proposed to address security issues are discussed and analysed specifically in the world of the Internet of Things. Meanwhile, the challenges and future trends of the Internet of Things are also mentioned.

Keywords: Internet of Things, IoT, security, authentication, confidentiality, access control.

**PHYSICAL AND MATHEMATICAL SCIENCES**

**V. N. Zadorozhnyi**  
**Cascade method of realization of heavy-tailed distributions**

The paper solves the problem of moments' displacement at generating of random variables described with the help of the heavy tails distribution. The methods of solving the problem of moments' displacement are also proposed. There is developed the effective method for generating of random variables with the heavy tails distributions. The accuracy of the proposed method is evaluated.

Keywords: Fractal traffic, queueing theory, simulation modeling, random number generators.

**A. A. Romanova**  
**The analysis of batch scheduling problem with an objective to minimize total weighted completion time**

In this paper, we consider the batch scheduling problem with bounded size of batches, with an objective to minimize total weighted completion time. There is proved NP-hardness of this problem. Also it proposes the algorithm for finding an approximate solution. Results of numerical experiment are presented.

Keywords: batch scheduling, NP-hardness, approximation algorithm.

**CHEMICAL SCIENCES**

**I. A. Kirovskaya, P. E. Nor, A. A. Ratushnyi, E. N. Eremin, Yu. I. Matyash, S. A. Korneev**  
**Mechanisms of nuclear and molecular interactions on a surface of solid solutions  $CdTe_xS_{1-x}$**

With the use of methods of hydrolytic adsorption (measurement pH an isoelectric condition —  $pH_{izo}$ ), mechanochemistries, a nonaqueous conductometric titration, the IR-spectroscopy are studied acid-base properties of a surface binary (CdS, CdTe) and threefold  $((CdS)_x(CdTe)_{1-x})$  CdS system semiconductors — CdTe evacuated in atmospheric conditions, and also the gases (NH<sub>3</sub>, CO) subjected to influences. The nature, force, concentration of the acid centers are defined. The change of their force ( $pH_{izo}$ ) and concentration under the influence of the specified factors is estimated and at structure change. Possibility of prediction of the adsorption activity according to acid-base characteristics of a surface is shown. The fissile is revealed most in relation to CO adsorbent — the solid solution of structure (CdS)<sub>0,16</sub>(CdTe)<sub>0,84</sub> is offered as the primary converter of a sensor-sensing transducer on microimpurity of corresponding gas.

Keywords: diamondlike semiconductors, solid solutions, acid-base properties of the surface, the adsorption ativnost, regularities, primary converter, sensor sensor.

**I. A. Kirovskaya, P. E. Nor, A. A. Ratushnyi, E. N. Eremin, Yu. I. Matyash, S. A. Korneev**  
**Optical, electrophysical and luminescent properties of semiconductor materials on basis of system CdS–CdTe**

For the first time optical and electrophysical properties of binaris and multicomponents semiconductors of system are studied CdS–CdTe: on the basis of UF – and KR – spectroscopic researches defined values of frequencies of the impuriest (characterizing hexagonal modification) and interzonal luminescences, values of width of the forbidden region.

Keywords: semiconductors, solid solutions, nanofilms, optical properties, width of the forbidden region, luminescence.