# CONTENTS

# SUMMARY

## PHYSICAL AND MATHEMATICAL SCIENCE

**A. V. Adelshin, A. K. Kuchin**
**Accurate and approximate algorithms for MAX SAT problem solution**

In this paper we analyze the weighted MAX SAT problem with logical formula in conjunctive normal form. We introduce accurate combinatorial algorithm for solution of this problem based on integer linear programming models and L-partition approach, as well as local search algorithm with variable neighborhoods. In both algorithms, the sequence of special SAT problems is solved by the L-class enumeration algorithm. The algorithms are tested on samples from SATLIB library, the results of computational experiment are presented.

Keywords: maximum satisfiability problem, integer programming, L-class enumeration, local search, variable neighborhoods.

**V. V. Bykova**
**Complexity and elasticity of computations**

We offer a new quantitative trait, which makes it possible to measure the computational complexity of algorithms, to compare and classify the algorithms in the complexity. This is elasticity of functions of complexity algorithms. We give a characterization for elasticity of modern classes of algorithms.

Keywords: computation complexity, analysis algorithms.

**Yu. P. Makushev, T. A. Polyakova, L. Y. Mikhailova**
**Calculation and analysis of the indicator diagram of the engine using mathematical methods**

In the article it is considered the technique of indicator diagram building for the engine with the using a concept of "current" compression ratio and has been found indicator of engine operation by means of integration. It is given an example of the indicator diagram according which the analysis of engine technical condition has been carried out, and design of the sensor for determination of the pressure in cylinder of the engine is offered.

Keywords: compression ratio, indicator work, integration, indicator diagram, pressure.

**V. N. Zadorozhnyi, D. A. Tulubaev**
**Metamodel of complicated large-scale systems to control organizational and technical objects**

The metamodel of complicated large-scale systems to control organizational and technical objects is proposed. The metamodel describes technical systems as "generalized" queuing system containing a big number of entity classes and class parameters, which considered as random variables. The key measurable characteristics of the object, the feasibility of developing and implementing priority service disciplines are determined based on the metamodel.

Keywords: large-scale project management, queuing system, the cost of waiting, the service discipline, the optimal assignment of priorities.

## MACHINE AND THEORETICAL ENGINEERING

**E. N. Eryomin, Yu. O. Filippov, N. A. Davletkildeev, G. N. Minnekhanov**
**The analysis of structure of alloy ZhS6U by atomic force microscopy method**

The atomic force microscopy analysis of alloy ZhS6U is carried out. Changes of topography of the surface and distribution of phase contrast of the heat resisting alloy at its modifying by particles of carbon nitrided titanium are shown.

Keywords: heat resisting nickel alloy, modifying, atomic force microscopy, topography, phase contrast.

**A. S. Losev, E. N. Eremin**
**The influence of borides on structure and property of maraging steel**

The results of analysis of the structure and properties of deposited metal of maraging steel of Fe-Ni-Mo-Cr-V-Si-Ti-Al type alloy, hardened by boron compounds are demonstrated. The role of borides in formation of phase structure and a structural condition of a steel in the course of holiday is analyzed.

Keywords: deposited metal; maraging steel; boride; improving; thermal stability.

**O. A. Mamaev**
**Improvement of mechanical and tribotechnical properties of PTFE - based composites by optimization of their composition and technology**

The structures, mechanical and tribotechnical properties in dependence of influence and concentration of modifier and technologies regimes of production polymer composites are considered. The interplay between inbox of composites properties and phase, supermolecular structures of PTFE are showed.

Keywords: polymer composites, structure, property, durability, modifier, technologies regimes.

**A. P. Chumakov**
**Improving structural strength of the surface layer by impact-acoustic method with infusion of solid lubricant and supply of nitrogen into the processing zone**

This article describes a method that enhances the tribotechnical characteristics of the surface layer and roughness parameters by impact-acoustic processing in inert nitrogen medium.

Keywords: solid lubricant, tribotechnical characteristics, metal-based plasma, surface layer amorphization.

**V. A. Bartolomey, V. B. Masyagin**
**Procedure of estimation of linear technological dimensions on the basis of dimensional and precise parameters of a work piece**

The procedure including definition of average and minimum values of the clean-up allowances and their errors with the subsequent distribution of the clean-up allowance on steps of processing of a workpiece using the graph tree method, and also decrease and increase of operational tolerances to provide the errors of the clean-up allowance with application of linear programming is offered.

Keywords: linear technological dimensions, rough workpiece, clean-up allowance, graph, linear programming.

**I. A. Bushkov, V. B. Masyagin**
**Preparing of initial data for size analysis of technological processes of parts with cone-shaped surfaces**

Developing technological process for part production the size analyzes is conducted. To automaty this calculation the program "NORMAL" is developed. But this program produces sizes analyze of face-plane surfaces and diameter surfaces only. The purpose of this article is adaptation of this program for giving possibility to produce this calculation when a part has cone-shaped surfaces. This possibility is provided by substitution of cone-shaped surfaces by cylinder and face-plane surfaces.

Keywords: size analysis, cone-shaped surfaces.

**D. S. Makashin**
**Type and quality of cutting chips of a drilled hole in titanium alloy**

The analysis of the influence of geometry of a cutting edge of a drill on the quality of surface is resulted at drilling of titanium alloy. It is shown that drilling of materials of one chemical compound there is dependence between a deviation from cylindrical shape and the type of cutting chips produced.

Dependence between a root-mean-square deviation of the hole profile and a kind of cross-section of the cutting edge is obtained. The presented results raise quality of processing and reduce labor-intensiveness of drilling of titanium alloys.

Keywords: drilling, alloys of the titan, quality of a hole.

**F. N. Pritykin**
**Geometric method of analysis of instant positions of planar manipulator links with motion redundancy under the given trajectory of the output link**

In the work by means of analytical calculation and geometric plotting instant positions of planar kinematic chains of robot mechanisms with motion redundancy under the given paths of output link are done. It is determined by graphical method of planar area setting positions of possible instant centre rotations of some links of the mechanism. The geometric parameters of maneuverability of planar seven-link manipulator with motion redundancy appearing in the process of the syntheses of motion by the vector of velocity are obtained.

Keywords: planar mechanisms manipulator, geometric interpreting of the instant positions of robot mechanism, redundancy at motion on vector of velocities.

**K. V. Averkov, D. Yu. Belan**
**Designing tool for processing electric machine collector**

The article briefly analyzes the main damages of collectors of traction motors indicating the problems of milling operation of collector working surface of electric machines with the given basis, a new method of collector milling with a special cutting tool greatly affecting the quality of the processed surface. The tooth profile of cutter mill has been designed.

Keywords: Electromotor commutator functional surface, cutter mill, feeding size, basing

**E. S. Gebel, B. Zhursenbaev, A. Sarbasov**
**Kinematic analysis of linkage with changeable closed circuit**

For theoretical analysis of kinemics and of linkage design data are necessary for development of mathematical models. The choice of analytical model for each mechanism is defined by the mechanism scheme. A vector-matrix method is used for the kinematic analysis of a plane linkage with changeable closed circuit.

Keywords: linkages, kinematic analysis, vector-matrix method.

**N. A. Ivanova, S. S. Blinkov, V. S. Scthetinin**
**Method of calculation of gas-magnetic bearing of high-speed spindle unit**

The method of calculation of bearing ability of high-speed spindle unit with gas-magnetic bearing is examined. The influence of magnetic force and forces, which had been created by gas layer from out air submission, and gas-dynamic effect on characteristics of spindle assembly, was taken into account.

Keywords: spindle assemblies, gas-magnetic bearing, spindle bearings, gas-static bearings, bearing ability, rigidity spindle assemblies.

**P. D. Balakin, E. A. Kuznezov, P. A. Prozorov**
**The mechanism of wear-resisting formation of clearance in moving joint with power pulse loading**

The mechanism of clearance formation due to plastic deformation of elements of loaded joint of varying force and development of automatic compensation and other compensation of such a clearance is developed.

Keywords: dynamic loading, plastic deformation, forming of clearance, compensation of clearance.

**M. I. Biserikan, A. V. Obryvalin, A. A. Rauba**
**The influence of technological heredity on contact stress in the wheel rail**

The article considers the influence of technological heredity irregularities due to lack of effective technology to repair the process of contact interaction and the stress strain state in wheel rail. The article presents the model of processing solid wheel allows you to achieve the necessary quality of the surface.

Keywords: wheel increased hardness, thermomechanical damages, technological heredity, stress-strain state, endurance breakdown.

**A. S. Nenishev, A. G. Mikhailov, P. A. Batrakov**
**Heat transfer in the flow of reacting gases in small boilers**

The problems of the intensification of the radiation and convection of heat transfer in furnaces of gas turbine boilers are analyzed. Possible generation scheme of swirling flows are offered.

Keywords: combustion, furnace, heat, radiation, convection.

**Yu. A. Buriyan, V. N. Sorokin, A. A. Kapelyukhovsky**
**Control system of intensity of elastic waves radiation of borehole generator**

In the work possibility of design of extreme control system of intensity of radiation a borehole hydrodynamic radiator of elastic waves using strengthening of intensity of sound adjusted in the resonance with frequency wedge tone of elastic cores is considered.

Keywords: borehole, hydrodynamic radiator, resonant frequency, liquid expense, extreme control system.

**A. V. Gruzin, V. V. Gruzin, M. V. Kucherenko**
**Methodology for calculation of equipment parameters for high-speed video shooting of shock influence of model on ground**

The presented article considers calculation methodology of parameters of the equipment for high-speed video shooting of shock influence of model on ground.

Keywords: calculation of parameters, a high-speed video shooting, shock influence, a ground.

**V. N. Blinov, S. I. Zubarev, V. V. Shalay**
**A mathematical model of thermal mode of evaporator electrothermal thruster correction of spacecraft**

In this article heat calculation is done of evaporator electrothermal thruster of correction in which the gasification of the working fluid (ammonia) is used. Mathematical models for steady and unsteady modes of the evaporator are developed. The comparison of the data obtained with the known data of telemetry is carried out.

Keywords: ammonia, ammonia gas supply, electrothermal thruster, evaporator, mathematical model

**V. N. Blinov, V. P. Doronin, L. N. Nazarenko, V. V. Shalay**
**Mathematical model of interior chemical kinetics of ammonia electro-thermal microengine of space vehicles correction**

The kinetics of ammonia decomposition in an electrothermal microengine is studied.
Dependence of decomposition ratio on temperature and residence time in the channel is found. Recommendations about the minimal length of the engine channel depending on the applied catalyst are given.

Keywords: ammonia decomposition, electro-thermal microengine, catalysis.

**V. I. Trushlyakov, V. Yu. Kudentsov**
**Launching space rockets and control of separated parts landing in target areas**

The analysis of existing methodical approaches to synthesis of schemes of space vehicle launching is carried out. The way of launching of space vehicles with controlled landing of separating parts in preset areas on the basis of technology of gasification of the rests of liquid fuel is offered.

Keywords: separating part, space launch vehicle, liquid residual of fuel, gasification, falling areas, orbit launching.

**A. V. Goryaga, A. M. Dobrenko, V. S. Serdyuk, O. A. Tsorina**
**Mathematical models of protection systems against risk factors of production**

In the work mathematical models of systems of protection against risk factors of production are developed. The offered models can be used for working out of the models of its operation in machine-building, petrochemical and other branches of manufacture.

Keywords: production, risk factors, mathematical models of systems of protection.

## ELECTRICAL AND POWER ENGINEERING

**A. V. Bubnov, V. A. Emashov, A. N. Chudinov**
**The method of indirect determination of rotational frequency error in electric drive with phase lock in saturation mode of logical comparator**

In the article the method of indirect determination of rotational frequency error in an electric drive with phase lock in saturation mode of the logical comparator is offered.

Keywords: electric drive with phase lock, logical comparator, conversion of the rotational frequency error.

**A. V. Bubnov, A. N. Chudinov, V. A. Emashov**
**The method of improvement of dynamics of electric drive with phase lock on the basis of indirect determination of rotational frequency error in saturation mode of the logical comparator**

In the article the method of improvement of dynamics of an electric drive with phase lock on the basis of indirect determination of rotational frequency error in saturation mode of the logical comparator is offered.

Keywords: logical comparator, electric drive with phase lock, the rotational frequency error.

**K. I. Nikitin**
**The analysis of changing of current phase of asynchronous engine at its start-up, experiment and synthesis of the device of relay protection. Part 1**

The analysis of changing of current phase of an asynchronous engine at its start-up is carried out. The technique of definition of the current phase of the engine at the moment of during self-start (start-up) is offered. The use of the given parameters distinguishes self-start from short circuit faster to reduce time of protection relay operation.

Keywords: self-start, short circuit, relay protection, the asynchronous electric motor, a current phase.

**A. G. Scherbakov**
**The method of identification of parameters of asynchronous engines**

In the given article the urgency of the problem of identification of parameters of mathematical models of asynchronous engines is analyzed and it is offered technique of identification of the parameters allowing to make identification in real time. The offered technique is based on optimizing methods.

Keywords: asynchronous motor, vectorial control, parameters of mathematical model of asynchronous motor, identification of parameters, optimizing methods.

**E. A. Tretyakov, N. N. Malysheva**
**Optimizing the choice of compensating devices in electrical 0,4 kV network at rapidly variable load**

There are technical solutions and the technologies allowing completely compensate invariable and rapidly variable reactive capacity component of load now. However, the problem on the choice of compensating devices and their parameters is highly actual. In the work the developed algorithm of definition of optimum analysis and compensating devices structure in consideration of demanded compensation invariable reactive power and variable components by criterion expenses a minimum is presented.

Keywords: reactive power, compensating devices, structure optimization of compensating devices, objective function, a minimum of the reduced expenses.

**V. V. Kharlamov, R. V. Sergeev, P. K. Shkodun, D. A. Akhunov, A. V. Dolgova**
**Identification of diagnostic variables for examination of traction motor collector cross-section**

This article is devoted to examination of quality of a traction motor repair and the influence of mechanical factors to reliability and stability of «collector-brush» contact. By the results of research some criteria proposed for evaluation of the influence of a collector cross-section to commutation and criteria of repair quality in depot.

Keywords: traction motor, collector profile, commutation, harmonic analysis, quality of maintenance, diagnostic variables.

**A. A. Plankov, D. S. Osipov, A. G. Lyutarevich, A.V. Ded**
**Problems of stability of technical means providing quality of electricity**

The article is devoted to the basic objectives of the study of stability of technical means providing the quality of electrical energy. The most common criteria for stability its comparative analysis is considered. Pre-identified most appropriate criterion for studying stability of technical means providing the quality of electric energy is obtained.

Keywords: quality of electrical energy, non-linear automatic control systems, linear systems of automatic control, methods of stability, the stability criteria.

**N. D. Shelkovnikov, D. N. Shelkovnikov**
**The way and device for automatic protection of electrical power lines from snow and ice covering**

The attention is paid to a prominent approach of removing ice covering from electric wires of power lines by sending powerful electric pulses through them that results in thermodynamic forces which determine condition for «throwing away» the softened ice.
The significance of automatic protection of power lines from ice covering is that by means of autonomous monitors installed on the electrical posts, a digital code is transferred via VHF radio canal to the dispatcher informing the coordinates and type of emergency situation, and the command onto the automatic switch to the protection system.

Keywords: power line, removing ice covering, diagnostics.

**O. A. Ibragimova**
**The decrease in fuel consumption of heat and power engineering facilities of Omsk**

There is an opportunity of combined generation of power by heat station and district-heating plant at peak performance period. Final results of combined production of heat power are reduction of fuel consumption of plants and extra generation of the electric power; it can bring extra profit. The simulation of the main system parameters is developed.

Keywords: cogeneration plant, peak-load district-heating plant, fuel consumption heat-power load, fuel economy.

**S. V. Panchenko, T. R. Samuylova**
**Problems of optimum management of investments at introduction energy conservation technologies on the basis of energy audit findings**

This publication sets out the approaches to the implementation of energy saving technologies, increasing energy efficiency and describing complex software «EnergyConservation» in the field of energy audit. The article raises the question about the efficiency of the new technology of deep cooling of flue gas of boilers and presents the view on how to reduce external investments. The article may be used in carrying out energy audits.

Keywords: energy efficiency, energy conservation, optimal management of investments in installing the deep cooling flue gas, software программные продукты «Energy Conservation» for carrying out energy audits.

## INSTRUMENT ENGINEERING, METROLOGY AND INFORMATION MEASURING TOOLS AND SYSTEMS

**A. A. Gorshenkov, V. A. Zakharenko, J. N. Klikushin, S. A. Orlov**
**Assessment of disorder level of temperature scale**

From the standpoint of the theory of identification measurements it is analyzed the structure of the international temperature scale. A method for quantifying the degree of disorder (randomness) of the results of temperature measurements is offered.

Keywords: structure analysis, identification of measurement, the degree of randomness, the international temperature scale.

**A. S. Anisimov, A. M. Minitaeva, N. S. Panova**
**Development the method of ecological monitoring of transport engines**

The method of equilibrium structure for calculation of fuel combustion products in transport engines is considered in this article.

Keywords: monitoring, the ejection of gas, burnt gases, Diesel engine, internal-combustion engine.

## INFORMATION TECHNOLOGIES

**V. V. Bykova**
**Asymptotic properties of solutions for special type of recurrence relations**

Two special types of recurrence relations that appear at the analysis of recursive algorithms are presented. The proof of the theorem defining asymptotic properties of the solution of recurrence relations with additive reduction of parameter recursion is resulted.

Keywords: software, computation complexity, analysis algorithms, recursion.

**V. A. Glotov, V. Yu. Ignatyugin**
**Mechanical engineers' training using computer technologies**

Mechanical engineers' education using computer technologies at «Mechanization of railway, loading/unloading and construction work» Department of Siberian Transport University have been examined.

Keywords: electronic model, degree thesis, computer technique, Compas-3D, unified approach.

**P. S. Lozhnikov, A. V. Eremenko**
**Approach to improving the reliability of authentication of PC users on the dynamics of writing their passwords**

Reliable user authentication is one of the key tasks to ensure the security of information resources. Password protection system is widely used at present time. It has a number of drawbacks. The biometric system of identification of users is developed for their elimination on dynamics of writing of passwords and the estimation of its efficiency is carried out.

Keywords: biometric identification, handwriting dynamics, graphic tablet, alpha and beta errors, recognition threshold, proper domain.

**A. M. Purtov**
**Integration of GIS technology and method of graph reduction analysis of transport networks**

The review of works using geoinformation systems on transport is done. The way of application of geoinformation systems and the method of reduction of graphs is developed for the analysis of routes in transport networks. The technology is shown on examples of the analysis of popular routes of Omsk.

Keywords: geoinformation systems, a method of a reduction of graphs, the analysis of routes of transport networks.

**A. A. Ivolgin**
**The module of a transport network**

The transport module of configuration, control, monitoring of radio relay stations of the system of mobile communication of the third generation is developed for leading cellular company of the Omsk area allowing to reduce quantity of man-hours of all stations of cellular communication necessary for service, and also decrease in expenses on operation and service of a motor transportation economy of the company.

Keywords: third generation of cellular communication of level of a transport network, radio relay stations, systems of monitoring and management of radio relay communication lines.

**A. O. Mishurin, A. A. Pyatkov**
**Estimation of minimum cost of the system of protection of information facilities based on the mathematical model of sides counteraction**

The paper describes a mathematical model developed in the field of counteraction sides for confidential information and approach estimating minimum cost of the system of protection of information facilities in the counteracting sides.

Keywords: mathematical modeling, the warring parties, minimize costs, the optimum point, information security, protection of information systems.

**O. N. Luchko , V. A. Marenko**
**Modeling the image of services sector enterprise**

The article deals with characteristics of commercial enterprise, as variables with the subsequent formalization. On this principle it is based the concept approach to modeling the image of services sector enterprise. The result assessment is carried out by the software developed by Delphi 7.

Keywords: modeling, automation, image, services sector.

**D. A. Tulubaev**
**Reliability and productivity of operative-dispatch services as queuing system**

The particular features of operative-dispatch service operation of oil-trunk pipeline maintenance are considered. The method for load optimization for operative-dispatch personnel is under discussion.

Keywords: queuing system, analytical-simulation modeling, oil-trunk pipeline, limit load of operative-dispatch personnel, anti-damage training.

**O. N. Demchenko, A. B. Korobova**
**The algorithm for teenage clothes design by combinatorial analysis methodology**

The perceptiveness and importance of combinatorial analysis method for teenage cloth computer aided design is discussed in the article. The description of the algorithm for a fragment of teenage cloth design is given.

Keywords: algorithm, data base, goods element, combinatorial analysis method.

**M. A. Zhbannikova, A. B. Korobova**
**The block diagram of algorithm for automation of contactless measurement of teenager figure deformations at designing of legs and hips zone clothes**

The efficiency and necessity of measurement of additional measures with help computer aided design is considered in the article; the aim and description of block diagram of algorithm of the program for additional measures determine is given.

Keywords: block scheme, algorithm of the program, date base, additional measures, optimal construction.

**I. V. Zyuzko, M. S. Knyazeva, S. P. Shamets**
**All-Russian student contests in Omsk State Technical University**

The results of 3rd round of all-Russian student contests and seminar for the exchange of experience in teaching engineering disciplines using actual information technologies in the Omsk State Technical University is analyzed.

Keywords: student contests, seminar for the exchange of experience, computer-aided design, actual information technologies.

**Brief messages**

**V. I. Sologaev, N. V. Zolotarev**
**Simulation of radial filtration by the method of spreadsheets on cellular phones**

This article considers numerical simulation of radial filtration on a cellular phone and as physical and mathematical modeling of the process, confirming computer analogue.

Keywords: radial filtration, mobile phone, spradsheets, computer simulation.

## RADIO ENGINEERING AND COMMUNICATION

**I. D. Zolotarev, V. A. Berezovskiy, D. D. Privalov**
**Studying transient processes in quartz resonators within the radio signal phase**

The paper studies the quartz resonator response to the square envelope radio pulse within a phase. The relationship for the radio signal envelope and phase at the quartz filter output is obtained without simplifying assumptions that is especially important for developing state-of-the-art radio-electronic systems in which the radio signal fine structure is the information carrier.

Keywords: quartz resonator, transient, radio signal phase.

**V. B. Malinkin, E. V. Malinkin, H. F. Kurash, O. V. Soboleva**
**A method for increasing noise immunity in the fiber-optic transmission systems**

A method of signal transmission with subsequent processing in the frequency domain are proposed. To implement such a treatment proposed structure based on direct and inverse Fourier transformation with an element of division, make possible the private information signals and training signals are respectively the current and subsequent processing unit.

Keywords: immunity, invariant, invariant under amplitude modulation, the probability of pair conversion, signal to noise ratio.

**A. I. Tyumentsev, V. A. Arzhanov**
**Analysis of modern technologies of microwave oven-appliances**

It is done the comparative analysis of modern technologies of microwave oven — devices, such as technology of thin films, «sandwich» and LTCC technologies. The conclusions about application of each of the considered technologies in manufacture of devices of the microwave frequency range are made.

Keywords: thin films, «sandwich»-technology, LTCC.

**J. V. Bashkatov, V. N. Horvat**
**The analysis of small size shortwave antennas**

The problem of shortwave antenna miniaturization is considered. As it is known the mini antenna problem is important for radio fans. In the paper the detailed analysis of mini antennas and their effective work with the range interesting to us are given. The experiment is carried out with help of antennas placed in the space and communication with the Earth is provided by computer software MMANA, Magnetic Loop Antenna Calculator.

Keywords: antenna, electromagnetic field, dipole antenna, shortwave link, degree of antenna efficiency, magnification constant, input resistance, line characteristic, magnetic transmitter, MMANA.

**A. N. Yuriev**
**Maximum communication range calculation procedure for the ground wave radio communication system**

The paper presents the calculation procedure for the maximum communication range provided by the ground wave radio communication system taking into account the transmitter power, receiving and transmitting antennas characteristics, signal type used for communication, operating frequency, and soil characteristics.

Keywords: radio communication system, ground wave, soil, field strength, noise figure.

**A. N. Yuriev**
**Theoretical estimation of maximum service zone of MHF trunked communication system**

The paper analyzes the possibilities for realizing the trunked communication system using ground waves within MHF range and maximally achievable

size of the servicing zone taking into account transmit-receive antenna characteristics. The uplink (mobile station-base station) transmission problems are considered.

Keywords: radio communication system, ground wave, soil, field strength, noise figure.

## PUBLISHING. POLYGRAPHY

**A. S. Borisova, L. G. Varepo**
**The estimation of adhesion durability of the combined materials by Micro Scratch Tester**

In the article the results of analysis of adhesive durability of the combined materials on the basis of aluminum foil are presented, the scratch-testings lead by means of installation of Micro Scratch Tester by company CSEM. Received Microphotos and graphic dependences, evidently illustrate process of destruction of masked foil and estimate adhesive durability of materials.

Keywords: the combined material, adhesion, durability, package.

**A. V. Golunov, L. G. Varepo**
**Ways of quality improvement of image printing**

In the given article results of analysis of properties of paper surface and cardboard are described. On the basis of experimental data dependence of the index of color rendition of material, its graphic and analytical interpretation is shown. Results of the given research have practical value at forecasting of quality of polygraph production.

Keywords: surface of paper, roughness, color gamut, quality.

## ENGINEERING GRAPHICS COMPUTER GRAPHICS

**L. K. Kulikov**
**Some properties of orthogonal projection in En**

In multi-dimensional Euclidean space En considers the vector approach to obtaining orthogonal projections of points, lines and p-planes in the projection plane of arbitrary dimension. This approach allows us to get more vivid projection figures and simple enough to study the properties of the orthogonal projection, which is necessary for multidimensional descriptive geometry and its applications.

Keywords: space, vector, p-plane, projection.