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**V. I. Wagner, I. M. Egorov, M. A. Egorova**

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#### **CONDUCTING A SYSTEM ANALYSIS OF THE VISCOELASTICITY OF POLYMER PARACHUTE STRAPS**

*Carrying out a systematic analysis of the viscoelasticity of polymer parachute lines is of paramount importance for a qualitative assessment of the deformation properties of these materials. Carrying out system analysis is based on mathematical modeling of relaxation and deformation processes of the materials being studied. Polymer parachute lines belong to the class of textile materials, as they are ribbons and cords made of synthetic threads. The system analysis carried out is based on the basic principles of the theory of viscoelasticity of polymers.*

**Keywords:** parachute lines, viscoelasticity, deformation, relaxation, creep, mathematical modeling, system analysis.

**A. V. Demidov, A. G. Makarov**

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#### **METHODOLOGY OF MATHEMATICAL MODELING OF DEFORMATION PROCESSES OF POLYMER TEXTILE MATERIALS**

*The article describes the methodology for mathematical modeling of deformation processes of polymer textile materials, which are actively used in many fields of technology. A mathematical model of deformation processes of polymer materials is, as a rule, a system of equations regarding the determined characteristics, associated with additional conditions. To obtain a unique solution to the system, it is necessary to set parameters, which can be experimental data obtained in the laboratory.*

**Keywords:** polymer textile materials, deformation processes, forecasting, mathematical modeling.

**E. S. Chistyakova**

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#### **MATHEMATICAL MODELING OF ELASTIC AND RESTORATIVE PROPERTIES OF POLYESTER YARNS**

*The article studies the issues of mathematical modeling of the elastic properties of polyester yarns of varying degrees of twist. Reducing the degree of twist within acceptable limits while maintaining the necessary mechanical properties of the threads reduces the time spent on the production process and brings economic benefits.*

**Keywords:** elasticity, polyester threads, deformation processes, forecasting, restoration processes.

**I. G. Drovnikova, A. D. Popov, A. D. Popova**

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### **VULNERABILITY ANALYSIS OF THE LINUX OPERATING SYSTEM BASED ON THE STANDARD CVSS**

*The article considers the capabilities of the CVSS version 3.1 standard to perform vulnerability assessment of an operating system. The results of analyzing some current vulnerabilities of the Linux operating system are presented. Conclusions are drawn about the effectiveness of using the CVSS version 3.1 standard for making informed decisions on the implementation of information protection measures aimed at eliminating vulnerabilities.*

**Keywords:** Linux operating system, vulnerability, vulnerability assessment, CVSS standard.

**M. A. Egorova, I. M. Egorov**

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### **METHOD FOR DIGITAL PREDICTION OF DEFORMATION PROCESSES OF TISSUE FOR TECHNICAL PURPOSE**

*Using the example of technical fabric used as the inner layers of protective helmets to protect the human head from injury, the process of predicting the deformation process is considered. The presented methodology is based on mathematical modeling of the creep process and makes it possible to predict with a sufficient degree of accuracy the deformation processes of sewing materials, including deformation-recovery processes of any degree of complexity, which gives grounds for technological selection of fabrics that have the specified impact-resistant characteristics even at the product design stage.*

**Keywords:** deformation, creep, viscoelasticity, sewing materials, forecasting, recovery processes, technical fabrics.

**T. K. Zhukabayeva, V. A. Desnitsky, E. M. Mardenov**

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### **APPROACH TO SIMULATION MODELING OF WIRELESS SENSOR NETWORKS FOR ATTACK DETECTION**

*The article examines issues of modeling of network layer attacks in wireless sensor networks (WSNs). As the basis for constructing a WSN simulation model, we use a developed full-scale network model, which implements a software/hardware prototype of a wireless network by applying microcontrollers and other electronic components. The simulation model is built on the basis of sequences of imperative rules that specify the principles of functioning of normal network nodes and nodes compromised by an attacker. The correctness and feasibility of the proposed simulation model is confirmed by its testing through using an example of detecting a wormhole attack aimed at disrupting the routing processes in the WSN.*

**Keywords:** attack, modeling, graph, detection.

**S. V. Kiselev**

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### **MATHEMATICAL MODELING OF DEFORMATION PROCESSES OF**

## **TEXTILE ELASTOMERS FOR IMPLANTOLOGY**

*The article discusses the issues of mathematical modeling of deformation processes of polymer textile elastomers for implantology, which are important for determining the functionality of these materials. The article also provides technical characteristics of a representative group of polymer materials used for the manufacture of textile elastomers for implantology.*

**Keywords:** research, mathematical modeling, elastomers, textile materials, deformation properties, relaxation, creep.

**N. V. Pereborova, A. G. Makarov**

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## **MATHEMATICAL MODELING OF DEFORMATION PROCESSES OF HEAT-RESISTANT ARAMID MATERIALS**

*Methods for mathematical modeling of deformation processes of heat-resistant aramid materials are considered. The basis for predicting the deformation processes of these materials are mathematical models of relaxation and creep. A technique is proposed for solving the problems of comparative analysis of the properties of heat-resistant aramid materials, studying the relationship between properties and structure, and predicting short-term and long-term mechanical effects.*

**Keywords:** viscoelasticity, aramid textile materials, mathematical modeling, computer forecasting, heat resistance.

**A. A. Kozlov**

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## **SYSTEM ANALYSIS OF RELAXATION AND CREEP OF POLYAMIDE FABRICS FOR PARACHUTE DOMES**

*The article discusses methods for systematic analysis of the relaxation and deformation properties of polyamide fabrics used for the manufacture of parachute canopies. System analysis is carried out on the basis of mathematical modeling and computer prediction of these properties. A comprehensive system analysis of the relaxation and deformation properties of polyamide fabrics used for the manufacture of parachute canopies allows for the selection of materials according to the criteria for best compliance with their functional purpose.*

**Keywords:** parachute canopies, polyamide fabrics, viscoelasticity, deformation, mathematical modeling, numerical forecasting, system analysis.

**A. V. Krasov, Alotum Yusef, I. A. Ushakov, V. V. Maximov, A. V. Arkhipov**

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## **USER AUTHENTICATION AND IDENTIFICATION USING BIOMETRIC KEYSTROKE DYNAMICS BASED ON “MANHATTAN AND EUCLIDEAN DISTANCE”**

*One of the major challenges of computer security is the requirement to protect confidential information and computer systems from intruders while providing easy access for user authentication. Passwords have traditionally been a standard mechanism for restricting access to computer systems, but this strategy has many disadvantages. But even the most powerful cryptographic systems cannot prevent*

*unauthorized access because they are static and determine validity based on the phrase that the user had to enter. Conversely, biometrics based on the “who” or “how” of a person represents a significant advance in security to address these new challenges. Identity verification is a natural use of biometrics, which are the physical attributes and behavioral characteristics that make each of us unique. Since biometric characteristics cannot be stolen, moved or impersonated, they become the most suitable candidates for authentication. The purpose of this paper is to extract typing characteristics, create a customized threshold for each password, and calculate Euclidean distance and Manhattan distance to make a user’s acceptance or rejection decision using keystroke dynamics, a behavioral biometric that uses a person’s typing tempo. Simulating typing behavior is difficult because it is ballistic (semi-autonomous), making it valuable as a biometric.*

**Keywords:** keystroke dynamics, manhattan distance, euclidean distance, threshold, biometric authentication, features.

**A. V. Demidov, A. G. Makarov, N. V. Pereborova**

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#### **MATHEMATICAL MODELING AND NUMERICAL PREDICTION OF THERMOVISCOELASTIC PROCESSES OF ARAMID TEXTILE MATERIALS**

*The article discusses the issues of mathematical modeling and numerical prediction of deformation-relaxation processes of aramid materials under variable temperature conditions. A generalization of methods for predicting nonlinear relaxation and nonlinear creep is proposed for the case of processes occurring under conditions of changing temperature by introducing temperature-strain-time and temperature-force-time analogies into consideration.*

**Keywords:** aramid materials, thermoviscoelasticity, deformation, mathematical modeling, numerical prediction, variable temperature.

**D. V. Kushnir, S. N. Shemyakin, A. V. Arkhipov, L. K. Sirotina**

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#### **ANALYSIS OF THE INDICATOR OF RESISTANCE TO LINEAR CRYPTANALYSIS USING THE EXAMPLE OF EDUCATIONAL CRYPTOGRAPHIC TRANSFORMATION**

*One of the approaches to assessing the strength of block encryption is to study the nonlinear properties of the transformations included in it. The article concludes that in order to form a stable nonlinear transformation, it is advisable to set the upper limit of the probability skew or the maximum value of the probability of performing a linear approximation.*

**Keywords:** block encryption, linear cryptanalysis, boolean function, linear approximation.

**A. G. Makarov, N. V. Pereborova**

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#### **METHODS FOR COMPUTER PREDICTION OF VISCOELASTICITY OF ARAMID TEXTILE MATERIALS**

*Methods for computer prediction of viscoelasticity of aramid textile materials are considered. Computerization of methods for predicting the viscoelasticity of aramid materials based on mathematical modeling of their deformation properties is inextricably linked with solving problems of comparative analysis of material properties, with studies of the relationship between properties and structure, with targeted technological regulation of properties, as well as with the prediction of short-term and long-term mechanical effects.*

**Keywords:** viscoelasticity, aramid textile materials, mathematical modeling, computer forecasting.

**A. V. Meleshko**

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### **ANALYSIS OF THE POSSIBILITY OF APPLYING THE THEORY OF PREPARATION AND DECISION MAKING TO ENSURE THE SECURITY OF WIRELESS SENSOR NETWORKS**

*The article is aimed at analyzing the applicability of the theory of preparation and decision making in the process of ensuring the security of wireless sensor networks (WSN) using the example of a self-organizing decentralized WSN. In connection with the growing use of WSN and the increasing complexity of their functioning, we can conclude that WSN can be classified as complex organizational and technical objects, attacks on which can lead to negative consequences. To identify and further counter various attacks, preparation and decision-making methods that are widely used in other areas of information technology research can be used. For example, the use of simulation modeling methods allows us to evaluate the feasibility of various attacks on WSN and will allow us to determine the most relevant ones. At the same time, decision-making methods contribute to more quickly identifying attacks and choosing countermeasures, for example, using data mining methods to detect current attacks on WSN. Therefore, building a simulation model of a WSN and attacks on it provides a deeper understanding of the specifics of the implementation of these attacks, which, together with an analysis of the feasibility of attacks, allows one to determine the necessary countermeasures to counteract attacks. Thus, the processes of preparation and decision-making make it possible to increase the security of self-organizing decentralized WSN.*

**Keywords:** wireless sensor networks, decision-making methods, self-organization, decentralization.

**E. V. Popova, A. D. Lihashva**

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### **CONTENT FILTERING ALGORITHM IN THE WEB APP FOR SELECTION OF WARDROBE**

*The aim of the study is to develop an algorithm for filtering content in a recommender system with explicit feedback in a web application for choosing a wardrobe. It is necessary to conduct a study of the new algorithm on quality criteria such as accuracy, novelty, ranking and diversity of recommendations and evaluate the complexity of the algorithm. The novelty of the work lies in the fact that two classical algorithms were selected that received the best performance for the selected criteria during testing, and on their basis a new algorithm was created that has performance*

*no less than the parent algorithms, with the exception of the operating time, which with modern technical devices is not critical. The results of the research are in the development of the theory of recommender systems, which are evaluated according to many criteria, and the possibility of introducing developments into web applications of small enterprises.*

**Keywords:** рекомендательные системы, алгоритм контентной фильтрации, критерии качества.

**I. V. Struchkov**

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### **DETECTION OF NETWORK TRAFFIC ANOMALIES USING AN ENSEMBLE OF CLASSIFIERS**

*Cyberphysical systems are an actively developing field of technology. The popularity of their application is related to the growth of automation, which leads to the integration of computing with physical processes. Thanks to this, they are able to provide more accurate and up-to-date information about the state of the environment. This makes it possible to react quickly to changing conditions and take appropriate measures to optimally manage groups of decentralised devices. In addition to traditional information security threats, decentralised cyber-physical systems are susceptible to threats of implementing specific attacks due to system properties such as manipulation of collective behaviour. The aim of the work is to improve the efficiency of functional task performance by agents of a decentralised cyber-physical system by providing trusted interaction between them. The scientific novelty of the study lies in the application of combined readings of individual chains of device interaction blocks by confidence criterion and coincidence of physical parameters to assess trust, followed by analysis of the obtained data to make a trust decision. According to the data obtained in the course of modelling, the proposed solution provides an increase in efficiency in terms of the average time spent and the probability of decision making.*

**Keywords:** trusted interaction, information security, distributed ledger technologies, cyber-physical systems.

**V. I. Wagner, N. V. Pereborova**

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### **MATHEMATICAL MODELING OF OPERATING PROCESSES OF POLYMER PARACHUTE SLINGS**

*Mathematical modeling of the operational processes of polymer parachute lines allows us to identify patterns of their dynamic behavior during the operation of parachutes, which is extremely important for conducting a qualitative analysis and assessment of the functional and operational properties of developed and existing parachute systems. On the basis of the specified mathematical modeling, computer prediction of stress relaxation and creep processes of the materials under study, fundamental in the theory of viscoelasticity, is also carried out.*

**Keywords:** parachute lines, viscoelasticity, deformation, relaxation, creep, mathematical modeling.

**E. S. Chistyakova**

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**METHODS MATHEMATICAL MODELING AND NUMERICAL PREDICTION OF DEFORMATION PROCESSES OF ARAMID MATERIALS**

*Mathematical modeling and numerical prediction of deformation processes of aramid materials used as rescue equipment during fires allows for both a comparative analysis of these materials according to the criteria of serviceability, and the selection of these materials that best meet the goal - saving people during fires.*

**Keywords:** aramid materials, mine rescue equipment, fire rescue equipment, viscoelasticity, deformation, mathematical modeling, numerical forecasting.

**P. I. Sharikov, A. Yu. Tsvetkov, V. V. Sigacheva, L. K. Sirotina**

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**INVESTIGATION AND ALGORITHM FOR PREVENTING EXPLOITATION OF LOG4J LOGGING LIBRARY VULNERABILITIES IN JAVA APPLICATION INFORMATION SYSTEMS**

*This work is a study of the vulnerability of the "zero-day" Apache Log4j logging library. The authors of the article investigate the severity of the vulnerability's impact on the information systems of java applications, consider situations in which, for a number of reasons, it is impossible to update the library version to a more up-to-date one. A model of the possible "depth" of using the library in an information system is given. A demonstration of the use of the vulnerability and an analysis of the threats that the exploitation of the vulnerability by an attacker can lead to. A set of measures has been developed that together make it possible to avoid exploitation of the vulnerability by an attacker, without the need to update the version of the logging library in information systems.*

**Keywords:** Log4j, log4shell, vulnerability, vulnerability 0-day, information system, java, WAF, JNDI.

**CHEMICAL SCIENCES**

**T. E. Litvinova, V. V. Vasiliev, N. V. Tuleshov**

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**INFLUENCE OF IMPURITIES OF VARIOUS NATURE IN ALUMINATE SOLUTIONS ON THE PRECIPITATION DEGREE AND PARTICLE SIZE DISTRIBUTION OF ALUMINUM HYDROXIDE OBTAINED BOTH BY THE BAYER AND SINTERING METHODS.**

*Aluminum hydroxide is of considerable value both as a raw material for further processing and as an independent product. Impurities that are presented in the feedstock and accumulated in technological solutions have different effects on the quality of the resulting product. This paper analyzes the available data on the effect of impurities on the precipitation degree and particle size distribution of synthetic gibbsite obtained by decomposition of alkaline aluminate solutions. In most cases, inorganic impurities lead to a decrease in the yield of aluminum hydroxide and the formation of a fine fraction of aluminum hydroxide. A number of impurities, mostly of organic origin, have a positive effect on the above parameters. The mechanisms of*

*such action of impurities, however, have not been adequately studied for most impurities, except for the oxalate anion.*

**Keywords:** aluminum hydroxide, alumina, impurities, Bayer process, alumina oxide, coarseness, precipitation, particle size, sintering process, precipitation ratio, decomposition, aluminate solution.

**Sh. D. Nabotov, I. N. Ganiev, A. G. Safarov, H. A. Asimov**

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### **ANODE BEHAVIOR OF THE ALUMINUM CONDUCTOR ALLOY AlZr 0.1 DOPED WITH SODIUM IN AQUEOUS NaCl SOLUTION**

*The anodic behavior of aluminum alloy AlZr0.1 doped with sodium in an aqueous solution of NaCl was studied by the potentiostatic method in the potentiodynamic mode at a potential sweep rate of 2 mV/s. It is shown that the free corrosion potential of AlZr0.1 aluminum alloy changes in the positive direction of the y-axis with increasing sodium concentration, and changes in the negative direction depending on the chloride ion concentration in the electrolyte. Increasing the sodium concentration in the parent alloy increases the potential for corrosion, pitting, and repassivation. Corrosion-electrochemical behavior of aluminum alloy AlZr0.1 in an aqueous solution of NaCl shows that doping with sodium up to 1 wt.% reduces the corrosion rate of the original alloy by 10-15%.*

**Keywords:** aluminum conductor alloy AlZr0.1, sodium, potentiostatic method, electrolyte NaCl, corrosion potential, pitting potential, corrosion rate.

### **AUTOMATION AND CONTROL OF TECHNOLOGICAL PROCESSES AND PRODUCTION**

**Ye. V. Yelaev**

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### **THE AUTOMATED SYSTEM FOR DIGITAL DEVICE COMPLEX TEST CHECK (CRIT)**

*The system for automating the process of test development for digital devices is considered in the article. The system is based on the use of a digital device model and allows to form a test as a set of input action. and model reactions to them. Input influences are formed within the framework of the interface approach, which accelerates the time of test creation. The structure of the system supporting the proposed technology and realizing the search of test sequences with a given coverage criterion is described.*

**Keywords:** test check, test inputs generation, computer-aided design system, test inputs generation, interface method.

### **AUTHORS LIST INFORMATION FOR AUTHORS**