# REVIEW OF METHODS AND ALGORITHMS OF SPEECH INFORMATION COMPRESSION IN DIGITAL COMMUNICATION SYSTEMS

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This article reviews the existing methods and algorithms for compressing voice information. The article reveals the urgency and necessity of developing the means of information exchange. It is shown that voice messages are the most natural and convenient way of information exchange. Hence, the author suggests that increasing the efficiency of voice communication via radio communication contributes to the development of the information exchange in human society, which in its turn is the crucial factor in the development of the defense, intellectual and economic potential of the state and society as a whole.
The article examines in detail the main directions of speech coding development. Methods of encoding a waveform and algorithms for coding a signal source are reviewed alongside. The main types of vocoders are listed and analyzed, their classification is introduced, the main characteristics and fields of application are described. The main task of speech compression algorithms is formulated, their practical efficiency is shown using the example of a digital radio station, which manages a data transmission channel. The article emphasizes the urgency of the development of new highly effective compression algorithms that open up perspectives for the development of digital radio communication facilities

Key words: speech signal, coding, decoding, codec, compression, vocoder

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# AUTOMATED INFORMATION SYSTEM OF DIGITAL SIMULATION OF STATIONARY RANDOM PROCESSES BY ALGORITHMS OF THE CONTINUED FRACTIONS

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The problem of digital modeling of stationary random processes affecting the research object often arises during the designing process of technical systems. To solve such problems, various modeling algorithms are being developed. In such case, the main requirement is to implement the algorithms using modern computing systems. The article describes an algorithm for digital simulation of stationary random processes with a given correlation function, based on the theory of continued fractions and the modified "Viskovatov's method". The algorithm makes it possible to obtain a digital model of a stationary random process in the form of a finite-difference equation and to estimate the accuracy of modeling using two criteria. This algorithm is implemented in the automated information system (AIS) "Digital Simulation of Random Processes", which implements the simulation of stationary random processes affecting the object of research. The AIS

operation sample presented in this article illustrates the basic possibilities of modeling and evaluating the model obtained, and also illustrates the "step by step" operation of the algorithm. The presented AIS is implemented in a free license licensing environment and is cross-platform, which makes it possible to use AIS for a wide range of researchers and will allow to expand its capabilities in the future

Key words: automated information system, random process, correlation function, continued fraction

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# OPTIMIZATION MODELING IN DECISION-MAKING PROCESS IN BUDGETING OF THE EDUCATIONAL ORGANIZATION DEVELOPMENT ON THE BASIS OF MONITORING INFORMATION

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Currently, the issue of forming the budget for the development of an educational organization, in particular, a general educational institution, is crucial. Initially, a set of managerial activities needs to be formed within the education institution for each development direction. In addition, it is necessary to identify a number of additional conditions related to the achievement of a certain level by those indicators that have negative dynamics over a certain period of time. Further, additional costs are determined for the implementation of each action of their three component investments. To determine the significance of the directions of development for the next financial year, joint expert evaluation is carried out using one of the methods of expert evaluation - the method of a "priori ranking". The ranking is carried out for each level of training. The task of the experts is to designate ranks that would reflect the significance of the development direction in a comprehensive way to choose the correct management strategies. Then, optimization modeling is implemented. It consists in investigating the influence of a variety of constraint options on the budget development review based on monitoring information received

Key words: expert estimation, optimization modeling, integral index, ranking

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# DEVELOPMENT OF THE SOFTWARE FOR CONTROL SYSTEM FOR THE DIGITAL SIGNAL SYNTHESIZERS

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The article introduces a block diagram of a signal synthesizer of arbitrary shape, consisting of a control module and a signal generation module. The main components of the control module are read-only memory, which was used as a chip NAND Flash memory, and a processor company ST Microelectronics STM32F439. The STM32F439 processor is used to control the signal conditioning module, as well as to organize the operation of the network interface. The signal

conditioning module is built using Xilinx XC7K70T programmable logic integrated circuit, DDR3 memory module, Analog Devices AD9739 digital-to-analog converter and bandpass filter.

Considerable attention is paid to the description of the software of the synthesizer of signals. One of the possible variants of implementing the software for the signal conditioning module is presented. It is a finite state machine that provides interaction with a digital-to-analog converter and the possibility of using the SDRAM DDR3 memory module as a random-access memory for storing samples of the generated signal. There is also a possible approach to the development of software for the control module of the synthesizer of signals, the main task of which is the organization of storing the formed signals in memory and servicing the network interface

Key words: digital signal synthesis, signal generation, FPGA, Verilog HDL

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# *Energetics*

## METHODOLOGY FOR IMPROVING THE EFFICIENCY OF COMPRESSOR STATIONS WITH GAS TURBINE GAS COMPRESSOR UNITS UNDER THE RECONSTRUCTION

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Improving the energy efficiency of compressor stations (CS) is an acute problem in the gas industry, since the gas compression is the most energy-intensive heat and power process. The article reviews modern methods of increasing the energy efficiency of compressor stations on the reconstruction phase; application of brand new generation of gas compressor units (GPU) with high efficient coefficient of performance gas turbine units (GTU), regenerative use of heat of exhaust gas of gas turbine plants, the use of a modular layout of gas pumping units, reduction of hydraulic resistance through the use of tubes with internal coating.

Mathematical modeling and calculation mode design applied to calculate the capacity of the compressor station during the replacement of gas pumping units as new power generation units are being enlarged. The use of the proposed approach to the reconstruction of compressor stations will improve the energy efficiency of compressor stations, reduce the power consumption of compressor stations and cut the cost of fuel gas sufficiently

Key words: compressor station, energy-efficient operation, gas compressor unit, gas turbine power plant

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# HARDWARE SOLUITON FOR A QUICK-SENSING CURRENT SENSOR FOR AUTOMATED CONTROL SYSTEM OF POWER CONSUMBTION WITH HIGH VOLTAGE AC REGULATORS

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The article reviews the methods of microcontroller installation of the phase shift sensor for high voltage regulators using various methods of determining the phase shift. Two types of the sensor implementation as a system for calculating the phase shift value are estimated: based on zero bodies (the system calculates the time between zero transformations of the transformed network voltage signal and the converted network current signal) and on the basis of the inverse cosine and sine transformation method with an estimate of the phase shift value in the period between the transitions through zero of the converted voltage signal and the current signal of the network.

The advantage of this method in obtaining the instantaneous phase shift value is shown, which makes it possible to achieve a high speed for regulating power flows in the networks and a rapid response to possible emergency disturbances. The simulation of the sensor is introduced in the article. The transient process graph was obtained in the case of an active-inductive load

Key words: compensating reactive power, current sensor, thyristor regulator

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# APPLICATION OF RAYLEIGH-PLESSET CAVITATION MODEL FOR THE ANALYSIS OF CRYOGENIC FLUID FLOW WITHIN THE PATHS OF TWO STAGE PUMP

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The article reviews the modeling of the flow of cryogenic liquid in the paths of a screw-centrifugal pump of a liquid rocket engine. The general description of the effect of cavitation pump failure is given. The method of computational fluid dynamics - ANSYS CFX package is chosen as a research tool. In the process of simulation, the Rayleigh-Plesset cavitation model is used. The relations of this model are derived from mechanical considerations without taking thermal phenomena into account. It is verified for liquid oxygen.

In addition, the article gives recommendations for the construction of a grid and the decision-making choices of boundary conditions for similar problems. Simulation was carried out for a separately standing auger and auger combined with a centrifugal wheel. The processes of cavitation failure and the effect of cavitation discharge are investigated for both systems. Inter- dependences of the cavitation caverns on the inlet pressure in the auger are illustrated. At cavitation unloading, the relationship between the difference in the rate of decrease of the relative parameters and the volume of the cavitation caverns is mentioned. Dependences of relative energy parameters at nominal and increased mass expenditures are reviewed. The mechanism of pump failure at increased mass flow rates is described

Key words: liquid rocket engine, feed units, cavitation, computer simulation

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## AUTOMATIC ADAPTIVE DRIVE CONTROL OVER EXCITATIMENT OF SEGMENT GENERATORS BY AIR GAP CHANGE

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The mathematical basis and experimental confirmation of the possibility of controlling the excitation of synchronous generators in segment execution by deliberately changing the air gap of individual modules of the active segment, (for example, moving the stator modules relative to the rotor elements), are reviewed in the article. Thus, the introduction of a new, previously unknown, channel for the regulation of synchronous machines with permanent magnets is justified, which gives the control system adaptive properties and ensures automatic control. This is being achieved by calculating the conformal mapping of the field in the working air gap zone, which allows us to find the analytical dependencies confirmed by experiment on the model of the magnetic system of the segment wind-generated generator. In particular, the curves characterizing the dependences confirm the initial theoretical position. Thus, as a result of the study, the possibility of introducing an additional impact on this object has actually been proved, which gives a synergistic effect: on the one hand, it becomes possible to reduce the counteracting moment on the windwheel at a constant low level load, with a small wind speed, and on the other hand, with an intense wind the energy output of the unit significantly increases, which ultimately improves performance. The structural scheme of a control system based on the principles of extreme control is given. As an extreme (optimal) characteristic, either the angular characteristic of the synchronous generator or the U-shaped one is either. The difference will be only in the sign. In the case of an angular characteristic, the system will use the "Signum Relay" and the "Switch" options to control the actuator that controls the gap
in predetermined limits

Key words: automation, adaptation, excitation of segment generators

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## *Radio engineering and communication*

# THE GENERATOR OF FREQUENCY MODULATED RECTANGULAR PULSES APPLIED TO THE SUB-MICRON TRCHNOLOGICAL BASE

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The article is devoted to the development of the generator of rectangular pulses, modulated in frequency. The generator is suitable for implementation in integrated form using topological rules in the sub-micron technological base. Architecture modulated pulse generator is based on the structure of an asynchronous RS-trigger. The peculiarity of the proposed generator is to expand the functionality of the standard asynchronous RS-flip-flop using the original circuit solutions. The trigger in the generator structure generates square-wave pulses. It is possible to eliminate the external oscillator meander. The oscillator circuit has two delay circuit incorporated in the circuit RS-flip-flop feedback, which enables the signal propagation time. Management is carried out through the use of an external oscillator control voltage. Changing the amplitude of the control signal causes a change in resistance of the feedback circuit and the signal propagation time. In the experimental studies of the construction of the generator rectangular pulses have to applied. To do this, the generator was set up in integrated form using standard base components technology library (submicron technology XH035 XFAB factory). High precision simulation of the device showed that the oscillator frequency varies over a wide range, from 47 to 94 MHz. In conclusion, the research designed oscillator topology using the basic technological elements of the library

Key words: square-wave generator, frequency modulation, pro-submicron design rules, MOSFET gates, logical elements

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# VARIETY STUDY OF EMERGENCY INTERFERENCE BIOPOTENTIALS

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In any system of remote control of human functional parameters the main link providing the necessary authenticity of the recorded information are the input analog nodes of the recording devices. The increase in the reliability of the recorded information is necessary for an accurate diagnosis and an objective timely evaluation of the actual functional state of the research object. Therefore, there is an urgent need to improve the noise immunity of the input analog nodes of the recording devices (micro-sensors, or recorders) without significantly complicating the circuit design of the devices.

In this article, the theoretical analysis of the nature of the interference and options for controlling them during the registration of bio-potentials is carried out. The main group of interference is identified, which requires suppression by circuitry methods. The ways of eliminating in-phase noise at the bio-potentials amplifier operating at the input of its additive mixture with a useful signal are considered. The analysis of circuit-based methods for suppressing in-phase jamming is carried out. The options for constructing the bio-potential amplifier based on operational amplifiers OP 191, as well as instrumental amplifiers INA 115, INA 118 are considered. Five main options for constructing amplification circuits are out of possible circuit solutions.

Based on the simulation results, five different circuit implementations of the bio-potential amplifier were compared. The effective structure of the circuit-based realization of the bio-potential amplifier was revealed. Based on the studies carried out, a bio-potential amplifier circuit was constructed. It has the largest common-mode rejection ratio

Key words: in-phase noise, additive mixture, bio-potential amplifier, micro-sensors-recorders

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# THE METHOD OF INCREASING THE RESOLVING CAPABILITY AND NOISE RESISTANCE SIGNALS IN NONLINEAR RADAR

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The article is devoted to the actual problem of increasing the resolving power and noise immunity of pulsed signals by the means of nonlinear location. The solution of the problem is carried via the installation of the nonlinear locator of two channels for processing the pulse signal in the receiver. The first channel allows using the modified direct wavelet transformation (MPVP) based on the Morlet wavelet to increase the resolving power of the receiver.

A qualitative analysis of the output signals for devices implementing the proposed method indicates an obvious improvement in terms of resolving power and accuracy due to the use of MPVP. The second channel is implemented after the block of MPVP and consists of a detector and two crossing blocks, connected in series with the delay elements, which ensures the convolution of the input partial impulses into one. The quantification of the quality of the noise-proof channel shows a gain of about 15 dB to 22 dB, depending on the type of interference distribution. The method for processing pulse signals and the presented circuit are original outcomes of the research. The degree of their study and research makes it possible to draw an unambiguous conclusion about the reliability, efficiency and appropriateness of further development and application of the device

Key words: nonlinear detection, crosscut procedure, direct wavelet-decomposition

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# ASSESSMENT METHOD OF ELECTROMAGNETIC PERFORMANCE OF PRINTED CIRCUIT BOARDS IN CLOSED STRUCTURES

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Currently, the problem of electromagnetic compatibility plays an important role in the development of radio electronic equipment. Most developers are trying to minimize electronic components, which increases the risks of failure in the operation of electronic tools. To save time and money, it is quite logical and expedient to identify the problem spots of the printed circuit board in the early stages of its development.

The description of the technique for the estimation of electromagnetic characteristics of printed-circuit-boards in the closed designs is presented in the article. Changes in the electromagnetic characteristics of the printed circuit board in a closed environment and in free space are described. Moreover, the article describes the change in the current flow in the L-shaped micro strip line. The emitting losses of printed circuit boards are compared as well

Key words: electromagnetic compatibility, printed circuit boards, housing, radiation

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# FM GENERATORS OF INFORMATION-TELECOMMUNICATION SYSTEMS APPLIED TO RESONATORS AND NARROW FILTERS ON SURFACE ACOUSTIC WAVES

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High demands are imposed nowadays on the frequency stability, the level of out-of-band and noise emissions, and manufacturability on the formers of radio signals in information-telecommunication systems. This is especially true for the UHF and microwave bands on which modern telecommunication systems operate. However, using the traditional method of transferring the frequency spectrum of quartz oscillators operates at relatively low frequencies to higher frequencies based on frequency multiplication results in a significant deterioration in the signal parameters. More promising is the use of FM generators applied surface waves (surfactants).

In this paper, a basic method for calculating the main types of nonlinear distortions that occur during the formation of FM radio signals is developed for the basic scheme of FM oscillators on SAW resonators for controlling the frequency of varactors operating in the barrier mode. The technique is based on the calculated ratios for the deviation of the fundamental frequency and its harmonics, the shift of the central frequency obtained using the static and dynamic modulation characteristics. Regimes are considered depending on the variation of the voltage amplitudes, control, high-frequency signals and bias voltage, which covers all possible modes of operation of the generators used in practice for varactors with sharp and super-sharp p-n junctions. This allows us to determine quickly and accurately the minimum levels of nonlinear distortions at the stage of preliminary design, based on the reference parameters of SAW resonators and used varactors.

The results of the carried out simulation and experimental studies indicate a sufficiently high accuracy of the coincidence of the calculation results and the experiment and the possibility of practical realization of the FM signal generators with small nonlinear distortions without the use of corrective circuits and the expediency of using the proposed technique in the sketch design. At the same time, by the level of noise radiation and the level of the output signal created directly by the self-oscillator, the investigated shaper significantly exceeds the parameters of the radio signals realized on the basis of quartz generators, which indicates the promise of its application in communication systems and measuring devices

Key words: SAW resonator, basic scheme, frequency deviation, varactor, central frequency shift, nonlinear distortions, modeling, experimental studies

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# METHODOLOGY FOR EVALUATING THE REFLECTIVE CAPACITY OF MIRROR ANTENNA WITH ABSORBING PLASMA, LOCATED UNDER THE SHELL

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The ability of a mirror parabolic antenna under a radio-transparent fairing with absorbing plasma to reflect an electromagnetic wave is reviewed in the article. A technique for estimating the reduction of the reflection of an electromagnetic wave from a mirror antenna due to the absorbing properties of the plasma is proposed. The method is based on the geometric-optic approximation.

Spatially homogeneous plasma model was used for the electro-dynamic model of possible plasma formations created in a closed volume (under the antenna shelter). The so-called quasi-optimal distribution of the electron density in the plasma, which reduces the reflectivity of the antenna in a given wavelength range, was constructed with the help of a spatially homogeneous plasma. In contrast to the previously known research, the mathematical relationships introduced in the article makes it possible to estimate the degree of reduction of the effective scattering area of a mirror antenna in a given range of wavelengths depending on the parameters of plasma

Key words: mirror parabolic antenna, radio-transparent shelter, absorbing plasma, reduction of reflection of an electromagnetic wave, method of geometrically optic optics

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# SPICE MODEL OF STABILITRON WITH INCREASED ACCURACY MODELING

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The shortcomings of the standard model of the zener diode are analyzed in the paper, by reviewing its current-voltage characteristics in comparison with the characteristics of the measured zener diode in the forward and reverse bias of the p-n junction. The standard deviation error was taken as the criterion of modeling accuracy. The proposed zener diode macro model improves the accuracy of the standard macro model by introducing into the subcircuit the built-in SPICE models, for responsible for a certain portion of the IV characteristic, and, in general, allows setting of the zener diode over the entire operating voltage range.

The modeling of the breakdown area most critical for the zener diode is reviewed in detail. In this paper, the method of extraction of the static parameters of Agilent Technologies is provided to illustrate the effects of the current recombination and high level of injection. The final analysis allows us to assess the feasibility of using the macro model, to determine its advantages and disadvantages, and also to make it possible for practical application in the field of semiconductor integrated

circuit design. The main advantage of the proposed macro model is a ready-made solution for use in any schematic simulation program supporting SPICE syntax

Key words: SPICE model, zener diode, macro model, SPICE parameters extraction

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# *Mechanical engineering and science of machines*

## THE EFFECT OF CONTACT SURFACES MICROSTRUCTURE ON THE JOINT FORMATION AT DIFFUSIVE WELDING OF TITANIUM

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The article describes the impact of the presence and thickness of a layer with fine-grained structure on the mechanical properties of diffusive welded joints. The appearance of the layer is provided by recrystallization during welding of metal, subjected to deformation during preliminary machining. The depth of the layer with deformation degree sufficient for recrystallization depends on the type of pretreatment and is from 8–10 microns at grinding to 25 microns at turning.

The tests are carried out on the samples from alloy OT4 with original coarse-grained structure. Contact surfaces of the samples are machined. Then the samples are divided into two groups, depending on the type of treatment before welding. The first one is directly subjected to welding after machining, which led to the formation of fine-grained material zone at the interface of the blanks during welding. The second group is subjected to vacuum annealing at 975 ° C (higher than the polymorphic transformation temperature) before welding to eliminate the effect of work hardening. Both groups are welded at temperatures of 800–1000 ° C and a pressure of 5 MPa, applied when the welding temperature has been established.

The experimental studies have shown that strength properties of the welded joints of the first group in the range of the temperatures studied and the welding time (up to polymorphous transformation temperature) have higher strength as compared with the samples from the second group.

The topography of the fracture surfaces of the welded joints shows that the first group of samples has developed relief, characterized both with transcrystalline and intercrystalline crack propagation at the fracture. The samples of the second group have a quasi–brittle fracture with a weakly developed relief. The destruction of the welded joint takes place on the plane of contact at intercrystalline crack propagation.

Thus, the presence of recrystallized layer that has greater deformation ability than the base metal in the contact zone will enhance the quality of the welded joint through creation of favourable conditions for the development of collective recrystallization and grain formation along the general line of the joint

Key words: titanium alloys, microstructure, diffusive welding, machining, recrystallization

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# CALCULATION OF ENERGY-POWER PARAMETERS OF HIGH-SPEED ORTHOGONAL CUTTING

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Modern finishing edge cutting machining for obtaining high quality surface and productivity is carried out with increasing speeds up to hundreds of meters per second. In this case the inertia properties of chip mass become meaningful because they increase the cutting forces due to the dynamic phenomena. This should be taken into account when calculating production modes and designing cutting tools. The article proposes a theoretical engineering model of orthogonal cutting with one plane of velocity discontinuity in feeding of the cut material. The model allows to estimate the maximum power and cutting force basing on variational principles of the theory of plasticity. The concept of dynamic cutting force coefficient is introduced. The coefficient indicates how many times the high-speed dynamic cutting force is more than slow static cutting force. A formula depending on the geometrical parameters of discontinuous velocity field is developed for its calculation. Numerical analysis has shown that significant dynamic inertial properties of the chips (the increase of the cutting force for more than 4 %) appear at cutting speeds of more than 100 m/s. It is revealed on the base of the variational principle of power minimum that the more the cutting speed is the thicker the chips are. Formulas for calculating the cutting power and its components depending on cutting speed are obtained. The developed model can be used in technological practice and when studying the mechanics of high-speed cutting and abrasive machining

Key words: cutting, hodograph of velocities, plane and angle of shear, dynamic coefficient of cutting, cutting power and cutting forces

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# INFLUENCE OF THE GEOMETRY OF TITANIUM PARTS AND LOADING DIAGRAM DURING WELDING ON THE FORMATION OF DEFECTS IN JOINTS

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The article presents the results of a study of stress-strain state of layered titanium structures with diffusive welded joints. The study uses the techniques that are based on the finite elements method and the theory of elasticity. The influence of the ratio of dimensions of the structural elements made of titanium alloys on the defects formation when welding are established basing on the analysis of the results of computational experiments. The contact pressure

distribution diagram is taken as the main factor that affects the nonuniformity of titanium transition to a plastic state over the contact surface of connection of the structural elements. The influence of technological sheet that transmits the pressure onto the welded workpieces on the distribution of the normal stress over the contact surfaces is revealed. The article also shows the calculated data of the influence of friction forces on the diagram of the contact forces distribution between the joined parts. Recommendations for designing titanium structures are given, as well as for defining parameters for technological diffusive welding, that ensure minimum probability of defects appearance during welding

Key words: sheet, filler, thickness, stress, contact forces, welding, distribution, plasticity, recommendations

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# CREEP OF MICROSTRUCTURAL LAYERED COMPOSITES

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An effective way to ensure reduction of billets deformation during diffuse welding is using mixed structures where sections with α-grains of globular and lamellar forms alternate. The article presents the results of the study of high-temperature creep of composite material obtained by diffuse welding of sheets with the structures mentioned.

The study is conducted using samples of 11.3 mm in diameter and 20 mm height from alloys OT4 and VT20, which are loaded with compression pressure of 1.0 to 20.0 MPa at temperatures of 850-950 ° C (OT4) and 900-975 ° C (VT20).

The work established that the creep rate of alloys with layered structures depends on the volume content of the coarse-grained material and the pressure application direction relative to the layers in composite workpieces.

In the case of load application parallel to the layers of the composite its creep rate decreases in direct proportion to the increase in the share of layers with coarse-grained structure.

When pressure is applied perpendicular to the layers of the composite its deformation is mainly caused by deformation of the layers with fine-grained structure and depends on their thickness and number. If the thickness of the layers with fine-grained structure is comparable to or less than the diameter of the sample, there appears an effect of their

contact hardening due to the restraining effect of the adjacent layers of the material with coarse-grained lamellar microstructure that have significantly higher resistance to deformation.

Formulas for calculation of lamellar composites creep rate have been obtained on the basis of the study

Key words: titanium alloys, creep, microstructure, composite

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## PROCESSING OPTIMIZATION FOR ELEMENTS ELECTROCHEMICAL MACHINING

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The article discusses the optimization of electrochemical machining, the basic optimization criteria and the special modeling characteristics for the issue. The main problem of optimization is the formation of a set of technological factors to be optimized, and the determination of optimal values of each technological factor.

Structural optimization provides selection of the best processing mode (technological scheme of electrochemical machining) in the case when optimum values of processing parameters are determined for each option, i.e. parametric optimization is carried out.

Parametric optimization means finding acceptable conditions of such a point, for which the selected optimality criterion has an extreme value. To solve the optimization problem methods of linear and non-linear programming are used. As a result, the optimal values of the parameters are found (the geometry of the electrode-tool, machine work load, etc.).

Complex optimization is performed using the principle of comparability, which includes structural and parametric optimization at the same time. The task of integrated optimization process is multifactorial. Its solution requires the development of scientific bases for electrochemical processing and optimization techniques, allowing to get the best productivity, the required surface quality, efficiency

Key words: optimization, criterions, electrochemical machining

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# IMPROVEMENT OF MATHEMATICAL MODELS FOR WORM GEARS FORMATION SUBJECT TO EVEN ALLOWANCE AT PROCESSING

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The use of the affine space mapping theory makes it possible to present a generalized mathematical model for the direct and inverse gears formation in a compact structural matrix form, as well as to develop mathematical models for specific geometric-kinematic schemes of shape formation.

The base length of each tooth is shortened in the proposed design of the worm cutter, due to the reduction in the working height of the tooth for the first, second and third passes, which makes it possible to reduce the angular teeth pitch in the end intersection and to form a greater number of racks on the same outer diameter of the worm cutter without decrease in the strength of the tooth. The increase in the number of racks gives a greater number of profiling cuts, which allows to increase the accuracy of machining, as well as to reduce the cutting unevenness and dynamic loads.

The article presents mathematical models for gears shaping subject to even allowance during machining. On the basis of the affine space mapping theory, rational angles of the dedendum for the second and third passes are found to be in the range $14^0$-$15^0$; the overlap of the profile is 0.25 m. Using the theory of designing the cutting part of the milling cutter teeth, it is established that the rear corners on the tip cutting blade close to the optimum values of 7° ... 9° are recommended for processing bronze wheel rims; the rear corners on the side cutting blades are minimum for the third pass and are within 2.31° ... 4.53°, which is acceptable.

With the established rational parameters, a worm cutter with a divided machining allowance has been machined and used to cut the worm wheels

Key words: worm cutter, worm wheel, tool rails, profile division

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## INCREASE OF PRODUCTION EFFICIENCY BY MEANS OF CHANGING THE SYSTEM OF RENUMERATION OF LABOR

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The article discusses topical issues of application of piecework and time-based forms of payment at industrial enterprises. Positive and negative aspects of application of these forms from the workers' and employers' point of view are shown, as well as statistics on the application of the time-based form of payment in Western Europe and the United States. The forms of payment at the industrial enterprise under study are described. The conditions necessary for transition of Voronezh industrial enterprises to time-based labor compensation are considered with the aim of solving the problems of optimization of forms and methods of labor remuneration. The list of provisions regulated by the document on the payment of labor for employees within the framework of the transition to the time-based system is given. Indicators that make it possible to compensate for the loss of the workers in wages in comparison with piece-rate pay are considered, as well as those that distribute the laboriousness of products manufacturing in order to evenly allocate the workload during the shift. The article gives an example of formulas for calculating these indicators used in the particular industrial enterprise that make it possible to increase workers' interest in labor results, which is a prerequisite for increasing labor productivity and improving production efficiency as a result of switching to the time-based form of payment. The conditions for awarding

employees within the framework of the developed time-based wage system are described. Formulas for calculating bonus remuneration for the described bonus payment provisions are considered. The volume and sources of funds directed to employees' remuneration, determined within the available financial resources of the enterprise are described. The position, regulating the composition of the elements comprising worked and not worked time, developed within the framework of the shift to the time-based labor payment is given

Key words: production efficiency, labor productivity, time wages, piece-rate labor, industrial enterprises, labor results

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# COMBINED PROCESSING OF EXTRUDED MATERIALS

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The article examines the features of combined finishing of extruded materials with various conductivity depending on the provision of the tool-electrode relative to the force vector during the pressing. The component parts made using the methods given in the article have the shape closest to the shape of finished parts, but there are always some areas where the designated accuracy is provided by final processing. This process is very labor-consuming since powder materials have various mechanical, heat engineering and electrotechnical characteristics where each area requires its own technological mode. It is difficult to carry out such mechanical operation even with the use of modern materials, tools and the high-automated equipment. Electric methods of processing are more and more in demand, often in combination with other processes or with different types of thermal, chemical, mechanical, magnetic, nuclear impacts. Recommendations about the choice of the technological modes of materials in relation to processing with wire electrodes are provided in the article, which gives an opportunity to project new technological processes, including those with the use of automated systems of technological preparation of production

Key words: extruded materials, specific conductivity, combined processes, technological processes, modes

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# INFLUENCE OF GAS-SATURATED LAYERS AND OXIDE FILMS ON THE IMPACT TOUGHNESS OF TITANIUM ALLOYS OF DIFFERENT STRENGTH

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Nowadays, when producing sheet titanium constructions, it is greatly demanded to make the surface of high quality, notably to remove gas-saturated layers and oxide films by etching. In the opinion of the majority of authors, the formation of oxide films and gas-saturated layers leads to the reduction of strength and fatigue characteristics of the base metal. However, according to literary sources, there are some data about positive effect of partly saved gas-saturated layers on the mechanical properties, which allows to reduce the irretrievable metal loss.

The article studies in details the influence of the hardness of preformed gas-saturated layers and finishing annealing temperature on the impact toughness of titanium alloys of different strength - VT1-0, PT7M and VT6ch. For this purpose regulated gas-saturated layers were formed, exposed to high-temperature annealing, sandblasting and chemical etching. Impact toughness (KCU) tests were taken in accordance with regulations of State Standard 9454-78 with the use of special equipment.

It is shown that the impact toughness of technical titanium VT1-0 and low-strength alloy PT7m can increase significantly under the optimal annealing temperatures. The length and microhardness of gas-saturated sublayer also influence the result

Key words: surface gas-saturation, annealing, impact toughness

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# POLYMERIC COATINGS WITH CORROSION INHIBITORS COMPLEX FOR ADJUSTABLE PROTECTION OF PRODUCTS OF DIFFERENT FUNCTIONS

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The results of a theoretical and practical justification of use of polyvinyl alcohol as film-forming substance for corrosion-protective coatings are presented. Availability of combination of water-soluble contact and vapor phase corrosion inhibitors as a part of a contact polymer composition with sufficient quantity of hydroxyl groups, providing shielding properties of corrosion-protective film, is shown. Use of vapor phase (sodium nitrite) and contact (cyclohexylamine) corrosion inhibitors is proved. Rational correlations of corrosion inhibitors, providing designated periods of products protection in certain environmental conditions, are positioned. For pure polyvinyl alcohol films and for alcohol containing a complex of inhibitors of various concentrations, point values of equilibrium sorption, diffusion and water permeability at $20^0$C are found experimentally. On this basis, the equations of diffusion permeability of the films with varied content of inhibitors of corrosion of different types are derived. It has been found that at augmentation of duration of contact of the film with the modeling medium, which leads to water diffusion into the sample, segmental mobility, free volume of the polymers matrix and, therefore, diffusion permeability of the film for substrate and complex particles increase, which leads to greater activity. The production technology of protecting coatings on the basis of water-soluble polyvinyl alcohol is defined

Key words: corrosion, inhibitor, polyvinyl alcohol, diffusion

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# LAWS OF ATOMIC STRUCTURAL SELF-ORGANIZATION OF THE IRON METALLIC GLASS MODEL UNDER CONDITIONS OF UNIAXIAL LOADING

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The study of evolution of metallic glass atomic structure under uniaxial pressure at the speed of $3{,}3\times10^{8}$ $c^{-1}$ and constant temperature of 300K is carried out in the frame of the molecular dynamics method on the basis of statistical-geometry and cluster analysis. The comparison of transformational dynamics of different types of coordination polyhedrons is carried out to examine the evolution of near atomic ordering during loading.

The dynamics of the decrease in the number of the source before loading coordination polyhedra of different types as the deformation is accumulated is analyzed. It is established that polyhedrons with a higher atomic packing density are less susceptible to rearrangement: (0-0-12-0), (0-1-10-2), (0-0-12-2), (0 -3-6-4), (0-2-8-2), etc. The most stable are icosahedra (0-0-12-0). At the same time, the total number of polyhedra of any type during deformation remains practically unchanged. Thus, the restructuring of the atomic structure of glass is self-consistent, while the quantitative ratio between different types of interfacing coordinating polyhedra remains unchanged, and the reproduction of the icosahedral sub-structural organization of the system as a whole is ensured.

The analysis of mutual transitions between icosahedra (0-0-12-0) and other coordination polyhedrons is carried out. The largest part of all the polyhedra into which the icosahedra transform, and vice versa, from which icosahedra form, is polyhedra (0-1-10-2) and (0-2-8-2)

Key words: metallic glass, deformation, structural self-organization, coordination polyhedron, Voronoi polyhedron, icosahedron

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