# ABSTRACT AND REFERENCES

## MATHEMATICAL AND INFORMATION SUPPORT OF COMPUTER-INTEGRATED CONTROL SYSTEMS

### DESIGNING CONTROL SYSTEMS WITH CONTROLLER BASED ON INTERNAL MODEL WITH TWO DEGREES OF FREEDOM (p. 4-8)

**Yury Kovrygo, Taras Bahan, Andrey Uschapovskyi**

In describing complex heat-and-power engineering processes, the vast majority of models has the simplification of behavior of the control object. In practice, it does not allow to set the controller promptly, but only to obtain approximate parameters. Moreover, the control objects in power engineering usually operate in maneuvered regimes, changing the load and internal parameters. The purpose of the research is the synthesis of the controller, which would provide the set-up quality indexes of transient processes, regardless of the model inaccuracy or changes of equipment parameters during operation.

The advantages of controller with the internal structure were considered, the stability of the closed - loop system is achieved by selecting stable IC-controller. N∞-norm was taken as the control error estimate. The quality indexes of transient processes in the system with IC-N∞ controller directly depend on one controller parameter, which makes its setting very easy.

The resulting structure of the controller may have two degrees of freedom, which improves the quality of transient processes for different control channels, as there is an opportunity to improve the quality of transient processes independently of one another.

On the example of ARS of the steam temperature behind upper radiation part of once-through boiler, simulation modeling and comparative analysis of IC controllers with one and two degrees of freedom was carried out. Using the designed controllers allows to ensure sufficient stability margin while maintaining performance and other quality indexes of the regulation system in the entire operating range of loads of the control object.

**Keywords**: regulation, controller, robustness, quality, index, stability, model, synthesis, function, sensitivity.

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### OPTIMAL AGGREGATION OF PRODUCTION SYSTEMS WITH PARAMETRIC CONNECTIONS (p. 9-19)

**Taisa Borovska**

Today, all conditions for effective functioning and development of production systems, with the exception of effective mathematical models for the new production management problems are provided. Based on the analysis of the state of theory and practice, requirements to models of production systems: absence of restrictions on the type of production functions, except for non-strict monotony and non-strict positivity; eliminating the dimensionality problem for optimization problems; isomorphic mapping of the structure of the production system in the decomposition structure of the optimization problem were formulated. To solve the problem of optimal control, methodology of optimal aggregation of production systems was used. The key point of this methodology is the decomposition of multidimensional nonlinear programming problem in the system of one-dimensional optimization problems. The structure of this system corresponds to the structure of the resource connections in the production system. Solutions for optimal aggregation of typical structures of production systems with parametric connections: "production – development", "production – warehouse", "production with recycling" that satisfy the set requirements were first obtained. The properties of this class of models for production systems are insufficiently investigated. Concrete results of modeling for these tasks were presented in the paper. Models are open for modifications and customization to specific segments of the production.

**Keywords**: modeling, production function, development function, algebraization, binary operator, optimal aggregation.

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### DEVELOPMENT OF INFORMATIVE SUPPORT FOR AUTOMATIC ANTISURGE PROTECTION SYSTEM AND REGULATION OF GAS PUMPING PLANT (p. 20-24)

**Georgiy Sementsov, Lidiya Davydenko**

The article deals with the nature and advisability of further informative support for automatic antisurge protection system and regulation of gas pumping plant boosters of natural gas storage compressor station based on improved performance of existing antisurge control systems by applying the method of data fusion.

The study was conducted at gas compressor unit № 9 (booster compressor station, natural gas storage "Bilche-Volytsya").

The analysis of the statistical characteristics of informative indicators as the rate of gas pressure increase: evaluation of mathematical expectation, variances, normalized autocorrelation function, spectral density, distribution law has been done. The autocorrelation function

of the degree of gas pressure increase was analyzed too. The equation of the autocorrelation function was shown to have two components: the exponential and cosine ones.

Amplitude and phase response of shaping filter for the degree of increase of gas pressure centrifugal blower gas-compressor unit was evaluated having done the analysis of experimental results.

The advisability of the method of data fusion in automatic anti-surge protection and regulatory systems was proved.

**Keywords**: automation, surge, system, regulation, compressor, support, evaluation, characteristics, filter.

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## ASYMPTOTIC MODELING OF TECHNICAL SYSTEMS WITH TECHNOLOGICAL DEVIATIONS (p. 25-31)

**Viktor Olevskyi**

A new asymptotic modeling method of complex technical systems, such as thin-walled shells, focused on numerical calculation of their parameters in the presence of technological deviations from the perfect structure was developed. A scheme of the method was presented.

Initially, a reduction of the boundary problem for a system of partial differential equations to a problem for ordinary differential equations is performed by expanding all quantities in Fourier series. Then, the system is transformed to the normal form, and its modification is made by expanding all the components in the multivariate Maclaurin series by degrees of the independent variable and the desired functions. An artificial parameter is introduced in equations, boundary conditions and form of the boundary under a special scheme, the solution is found in the form of asymptotic series by the degrees of the parameter.

The scheme provides a solution in the form of a Taylor series by the independent variable. Stability of the coefficients of the models at increasing the number of iterations and the convergence of approximations to the exact solution in its area of the meromorphy was proven.

Improved convergence of the asymptotic expansions in mathematical models of technical systems that are built under the developed method due to the generalized meromorphic summation based on two-dimensional Pade transform was shown. Special scheme of transforms, providing their existence, uniqueness, and convergence to the exact problem solution was selected.

Numerical verification of the developed modeling method on classes of singular and non-linear problems was carried out. The advantages of the method, such as a high rate of convergence in the area of the meromorphy of exact solution, calculation stability of the coefficients of the model at increasing the number of iterations, computation of the initial approximation and all subsequent differential equations in accordance with the form of the system were demonstrated. The mathematical models of stability of smooth thin-walled cylindrical shell under uniform external pressure and free oscillations of a stringer cylindrical shell were constructed.

The proposed asymptotic modeling method can be used to solve the problem of reliable prediction of the state of thin-walled shells with imperfections.

**Keywords**: modeling, asymptotic series, Pade transforms, technological deviations, thin-walled shell.

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## OPTIMIZATION OF ANALOG INTERFACE OF INFORMATION-MEASURING SYSTEMS FOR REMOTE MEASUREMENT OF MECHANICAL QUANTITIES (p. 31-37)

**Volodymyr Kvasnikov, Dmytro Ornatskyi, Oleksandr Osmolovskyi**

The error analysis of the analogue interface generalized structure with the standardized signal 4-20 mA is considered, the algorithms of calculating the filter parameter to prevent the effect of spectrum aliasing during input signal sampling are presented, and the reason of frequency of sampling and bitness of ADC (analog-digital converter) is given. The proposed method for optimizing the analogue information-measuring system interfaces for remote measurements allows more thoroughly consider the issues of accounting errors during designing information-measuring systems for mechanical quantities. Regulation and accounting of error features of the measuring systems IMS (information-measuring systems) has special peculiarities: it is better to prefer error regulation with separation into components, and also to regulate error features for stable service conditions taking into

account metrological characteristics of a computing component. The analogue interface error classification and the main error structure is proposed, and also underlining the analogue interface in the measuring channel structure as the nexus between the sensor and data gathering system to satisfy all the demands. Such method allows taking into account all the analogue interface error components in better way and obtaining the computation correlation both for signals with continuous spectrum (in a root-mean-square metric) and for determinated signals (in a uniform metric) for antialiasing filter parameters.

**Keywords**: analogue interface, sampling frequency, correlation between signal and noise, antialiasing filter

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## INFORMATION TECHNOLOGY OF DIAGNOSTICS OF ELECTRIC MOTOR CONDITION USING VOLTERRA MODELS (p. 38-43)

**Svetlana Grigorenko, Sergey Pavlenko, Vitaliy Pavlenko, Alexander Fomin**

The considerable growth of researches on the nonlinear systems based on the Volterra mathematical apparatus of integro-power series was generated by the necessity of using models of real objects of control and operation of enhanced accuracy, totally different from linear models. Moreover, they allow to develop by analogy the created methodological base for solving tasks of identification and diagnosis of dynamic systems at an entirely new level. This research provides the information diagnostic technology of motor operating conditions, which is based on the methods of non-parametric identification of control objects (CO) and building the decision optimal classification rules in the diagnostic feature space. The non-linear dynamic models in the form of the Volterra multidimensional kernels are used as the diagnostic information source, which are identified according to the results of the experimental studies of the control objects "input-output". The obtained with the help of simulation modeling results of studying the informativeness of the diagnostic features formed on the basis of the Volterra kernels allow to make a conclusion on the effective use of non-parameter dynamic models in the form of the Volterra series for diagnosing electric motors.

**Keywords**: information technologies, diagnostics, electric motors, non-linear dynamic models, identification, Volterra models

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pusk: Problemi avtomatizovanogo elektroprivodu. Teorija i praktika: Mizhvidomchij n.–t. zb. Kiiv: Tehnika, 66, 354–355.

## RATIONING EXHAUST EMISSION OF VEHICLES AND TRANSITION TO EURO STANDARDS (p. 43-49)

**Igor Primiskiy**

Influence of vehicle emissions in the environment is one of the most important environmental issues of our time. Composition and concentration of emissions of internal combustion engines of motor vehicles at the various modes of operation at different fuel type for both gasoline and diesel engines was analyzed. The features of state standards of Ukraine on emission norms, international standards - Euro standards, Rules of the United Nations Economic Commission for Europe (UN-ECE), the implementation stages and the effect of the Euro standards were considered. Construction principles, physical characteristics of measurement methods, specifications of devices that measure smoke (smoke meters) and toxicity of exhaust emissions (gas analyzers) were examined. The necessity of further modernization of modern national standards, harmonized with international standards, which have normalized the level of emissions from motor vehicles in accordance with the ever-increasing environmental requirements, was substantiated.

**Keywords**: vehicle, emission, norm, European standard, gas analyzer, stand, smoke meter, range, accuracy, regulations.

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## LOCALIZATION OF UNDERGROUND PIPELINES LEAKS BASED ON A COMPARISON OF ACOUSTIC PORTRAITS (p. 49-52)

**Victor Stroganov**

The method of leaks localization from underground water supply system on the basis of acoustic portraits pipelines comparison was proposed in the paper. The parameters of wavelet neuron network was suggested to use as the acoustic portraits, which was taught to approximate the acoustic signal, received on the soil surface above the place pipeline stowage.

Forehanded search and elimination of underground water supply leakages is an urgent task, which shows a considerable practical interest. The most promising approach to the search leaks was the passive location method, which is based on the analysis of pipelines acoustic signals. The information in this acoustic signal is sufficient to make a conclusion on the present or absence of leaks.

The author of previous research described the other way to search leaks, which is based on the signals' classification with the help of artificial neuron network. The significant drawback of this approach is the necessity to study ANN (artificial neuron network), and it demands a great scope of training data and time consuming. There is an alternative way in this research, namely the leakage search method on the basis of acoustic portrait comparison.

The acoustic portrait is the set of parameters, characterized the state of pipeline. The research results have shown that wavelet neuron network can be used as the acoustic portrait. The simplest criteria, the distance between parameter vectors, was used during the research to compare the acoustic portraits.

The leak search method described in this paper is characterized by low computational complexity and requires a small amount of training data and that is the main advantage. The subject of future researches should be the development of more effective acoustic portrait matching criteria.

**Keywords**: pipeline leaks, comparison of signals, wavelet neuron network, acoustic portraits of pipelines.

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