ABSTRACT AND REFERENCES

MATHEMATICS AND CYBERNETICS - APPLIED ASPECTS

APPROXIMATE SOLUTIONS FOR NONLINEAR BOUNDARY VALUE PROBLEMS OF DESORBED METHANE FILTERING IN HETEROGENEOUS COAL BEDS (p. 4-9)

Anatoliy Slesarenko, Igor Vengerov

A hierarchical modular approach to the mathematical modeling of nonlinear filtering processes of desorbed methane in heterogeneous coal beds is proposed. Practically demanded multidimensional models of methane delivery in the absence or in the presence of vertical and horizontal wells are based on the "models-modules", which, in their turn, are completed with the ordinary-simplest one-dimensional models.

An approximate analytical and numerical method for solving boundary value problems in non-homogeneous regions, in particular - in coal beds, containing two zones (the endogenous zone with constant filtration parameters and the exogenous one, adjacent to the initial cut, where porosity and permeability depend on the coordinates), is used.

The filtration equations are linearized and reduced to the equivalent heat-transfer equations. The solutions of four ordinary filtration problems are listed, which serve as a foundation for models-modules that are the components of different methane delivery problems.

Keywords: nonlinear boundary value problems of filtering, mathematical modeling, heterogeneous coal beds

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AXIALLY SYMMETRIC AXIALLY SYMMETRIC TEMPERATURE PROBLEM FOR THE BODY SYSTEM CYLINDER-SPHERE (p. 10-16)

Bohdan Okrepkyi, Andrii Aliluiko

The solution of the axially symmetric temperature problem for the body system cylinder-sphere, which lies on a rigid base with a circular notch in the case of isotropic materials, was built. The thermal contact between the bodies is assumed as non-ideal. The developed method for contact problems solution is based on using Hankel integral transforms and Fourier method of separation of variables for solving heat equations.

The solution of boundary value problem for finding temperature fields is reduced to the determination of some constants from the system of linear algebraic equations. As a result, formulas for determining the temperature fields at different temperature conditions on the lateral surfaces of the cylinder and the sphere were obtained. The influence of the contact conductance on the temperature fields distribution in the contact area between two bodies was investigated.

Numerical calculations and solution analysis indicate that the contact conductance significantly affects the temperature fields distribution in the contact area of two bodies.

Keywords: axially symmetric temperature problem, isotropic materials, non-ideal thermal contact, contact conductance

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STOCHASTIC MODEL AND METHOD OF ZONING WATER NETWORKS (p. 17-24)

Andrei Tevyashev, Olga Matviyenko

Water consumption at different time of the day is uneven. The model of steady flow distribution in water-supply networks is calculated for maximum consumption and effectively used in the network design and reconstruction. Quasi-stationary modes, in which the parameters are random variables and vary relative to their mean values are more suitable for operational management and planning of rational network operation modes.

Leaks, which sometimes exceed 50 % of the volume of water supplied, are one of the problems in water-supply systems. One of the ways to reduce leaks is zoning (overpressure zone definition) and pressure regulators installation.

The method of reengineering water networks by their zoning and pressure regulators installation was developed in the paper. Its implementation provides a significant reduction of the total overpressure in the water network nodes, water leak volumes and saving material and energy resources.

The improved method for zoning the water network is based on the stochastic model of quasi-stationary modes in the water supply and distribution systems, and pressure regulators parameters optimization for each determined zone.

Keywords: zoning, quasi-stationary mode, dispersion, pressure regulator, overpressure, stochastic model

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ADAPTIVE PROCESSING OF DATA OF MEDICO-BIOLOGICAL RESEARCHES BY COMPUTATIONAL INTELLIGENCE METHODS (p. 24-28)

Iryna Perova

A new approach to processing data of biomedical researches using methods of computational intelligence is considered in the paper. It lies in fulfilling three stages of data processing: preliminary data preprocessing, which includes rational coding of information; reducing the dimension of space attributes; data clustering. Each stage is essential for achieving the result, which will satisfy a researcher. A peculiar feature of the approach lies in using a unique processing technique with the known and unknown data distribution law, i.e. the law of data distribution does not affect the method results. In addition, the method is not sensitive to the ratio of the amount of objects under research and the amount of indicators, designating these objects. The offered approach implies data processing at a limited sampling (known quantity of objects) and at an unknown beforehand sampling, when data about research targets may be introduced during processing, and can be used for processing medical data samples of various origin. As a result of the proposed method, doctors will receive necessary information about the degree of closeness between objects, about the form of data distribution in the space of attributes and the amount of homogeneous groups (diagnoses) in a given sampling.

Keywords: computational intelligence, neural network, cluster, centroid, membership degree

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THE ANALYSIS OF POLYNOMIAL METHODS ON EVALUATION OF PARAMETERS OF CORRELATED NON-GAUSSIAN RANDOM QUANTITIES (p. 29-33)

Volodymir Palagin, Alexander Ivchenko

One of the possible solutions of the evaluation problem of parameters of non-Gaussian random quantities at their moment-cumulant description at the correlated sample is considered in the paper. The analysis of the algorithm of the adapted polynomial maximization method for finding the estimates of scalar parameter of statistically dependent non-Gaussian random quantities is given. It is shown that using the correlation measures to describe statistically dependent random sequences allows to adapt the polynomial maximization method for the case of correlated quantities. The type of stochastic polynomial, on which the correlated random sequence is distributed, according to the polynomial maximization method, is formed taking into account correlations.

Using the polynomial maximization method, adapted to the correlation case for estimating the scalar parameter of asymmetric correlated random quantity is shown in the paper. It is shown that the variance of the obtained estimates at constant values of the sample volume is smaller than the variance of the estimates,

obtained using the polynomial maximization method, unadapted on the correlation case. It should also be noted that taking into account the non-Gaussianity of the studied quantities in polynomial maximization method algorithms allows to obtain estimates with the best probabilistic features compared with classical algorithms of the method of moments

Keywords: evaluation of parameters, sample, non-Gaussian random quantity, correlation, polynomial maximization method

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APPROXIMATION OF STABILITY FACTOR ESTIMATE OF SαS-DISTRIBUTIONS (p. 34-38)

Vadim Shergin

The problem of approximating a stability factor estimate of alpha-stable distributions, obtained by the method of fractional moments, has been considered. Such distributions are widely used in models of stochastic processes, describing a wide range of processes and phenomena.

The analysis of existing methods for estimating parameters of stable distributions has been carried out. One of the new and promising methods for solving the problem under consideration is the method of non-integer (fractional) moments.

It has been noted that the formula for calculating the stability factor estimate, developed in accordance with this method, contains a non-elementary and rarely used function (inverse to a gamma function), that significantly complicates using such estimate in applied problems.

The problem of approximating the stability factor estimate has been set and successfully solved in the paper. The original dependence has been approximated with a simple fractional-linear function with quite a sufficient practical accuracy.

The suggested approximation has given an opportunity of adjusting an asymptotic variance estimate of the parameter under estimation regarding its true value. As a result, the discrepancy between a theoretical estimate and the data of numerical experiments has been eliminated.

The conducted numerical modeling has fully justified obtained results.

Keywords: stable distributions, stability factor estimate, fractional moments, asymptotic variance of estimates

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APPLICATION OF SHEDULING MODEL FOR PROJECT MANAGEMENT IN CONSTRUCTION (p. 39-42)

Anatoliy Usov, Sergey Maksimov

The paper deals with investigating project implementation dynamics taking into account the project life cycle features that is achieved by constant monitoring and analyzing the project progress, collecting and verifying its operation parameters and evaluating possible results of its implementation.

High degree of uncertainty and the associated risk, accompanying the implementation of construction projects, require the development of appropriate models to reduce project risk.

The paper aims at improving the construction projects management efficiency by studying and developing scheduling models and their implementation mechanisms.

This can be achieved by solving the following problem: obtaining the construction project duration reduction model based on the scheduling model of optimal work volumes distribution in time between the structural units. The scheduling model in terms of the maximum performed work volume was obtained, which differs by the original process graph transformation into the aggregation network.

Using the equality of maximum flow values in the original and the transformed network allows to reduce solving the original problem to a sequence of maximum flow problems and apply the network programming method

Keywords: project management, scheduling, optimal work volume distribution, construction project duration

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MATHEMATICAL DESCRIPTION TYPIFICATION IN THE PROBLEMS OF SYNTHESIS OF OPTIMAL CONTROLLER OF FOUNDRY TECHNOLOGICAL PARAMETERS (p. 43-56)

Dmitry Demin

The problems of finding efficient in practice mathematical models for foundry technological processes should be solved based on the required combination of their simplicity and adequacy. In this case, typification, which consists in identifying general laws of mathematical description of process parameters, taken into account in various foundry processes, may be promising. Mandatory use of common process parameters, significantly affecting the controlled process, product quality formation and performance in various foundry technological processes is the initial prerequisite for solving the typification problem. The method for obtaining "typical" mathematical description is shown on the example of several major foundry processes, such as rods manufacture in the heated equipment, mixture distribution and thermal-time melt treatment. It is shown that such a description is a simple system of differential equations, in which typical for various physical processes technological parameters, such as equipment and bath temperature, as well as the level of components in the mixture-distribution system bunkers are used.

An example of using the typification-based mathematical description in the optimal controller synthesis problem is given, and the way of obtaining the performance-optimal transients in the controlled object is shown. Based on this, it was concluded that solving the typification problem allows to obtain simple mathematical models, which can be used in practical problems of synthesizing optimal control systems for foundry technological processes.

Keywords: system of differential equations, optimal controller, electric arc furnace, rod automatic machine, mixture distribution

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