MICHAIL KULESH

SCIENTIFIC EXPERIENCE

1. Scientific Field

- Scheduling theory, overall optimization methods.
- Wavelet-analysis as applied to one- and multicomponent signal processing.
- Seismic wave processing as applied to the determination of polarization parameters and the characterization of velocity dispersion and attenuation
- Asymmetric elasticity theory (Cosserat continuum theory), static and dynamic boundary-value problems in the framework of the Cosserat medium, experimental investigation for media with microstructure
- Molecular dynamics simulations
- Experience with mathematical and applied engineering packages (Ansys 5.3, MathCad 7.0, Mathematica 4.0, Matlab 6.0)

2. Realized Projects

- **Development of optimum timetable models for school**

  The problem of the optimum timetable drawing has been considered. For this problem decision the model which is formulated in terms of the scheduling theory has been offered. This model is a technique of a timetable construction on the integer programming algorithms, which a based on the iterative improvement of the timetable. Besides, the problem has been formulated as multicriterial and multifactorial. The offered statement allows to construct rather effective optimization criteria using fuzzy sets theory.

- **Modeling of metal deformation process with use molecular dynamics simulation**

  Numerical experiments on studying of microcrystal reaction on external power influences with application of a molecular dynamics method have been considered. A number of the dependences has been constructed, and these dependences show, that the microcrystal reaction is much differ from a macro sample reaction to the same external influences. Practically there are no linear curves on the received deformation diagrams, and this fact is evidence of qualitative influence of micro effects (for example, essentially nonlinear kind of particles interaction potential) on the whole microcrystal behavior.

- **Development of experimental vibration-survey methods using continuous wavelet transforms**

  It is known, that prolonged vibrating power influences substantially define reliability and durability of responsible engineering constructions. In this connection the development of new methods of experimental vibrodiagnostics data processing as the primary information for the theoretical decision of reliability and durability problem, is extremely important and actual problem. In the given project the mathematical aspects and examples of continuous wavelet transform application for processing of experimental data, which are obtained by the vibrodiagnostics measuring of real buildings, have been considered.

- **Constructing of new analytical solution within the framework of asymmetric elasticity theory**

  In this project the fundamentals of the asymmetric elasticity theory are used to consider one- and two-dimensional static boundary-value problems. The exact analytical solution of each problem is compared with the corresponding solution obtained in the framework of the classical theory of elasticity. The comparison is made in terms of macro-parameters introduced to characterize the degree of difference between these solutions. The analysis of the obtained results shows that for each problem under consideration this difference is not essential. It is worthy of note that the macro-parameters used for comparison can be constructively measured by experiment. The obtained results can be used to outline a key diagram of experiments enabling one to detect the effects of "couple" response of the examined medium.

- **Calculation on toughness for the construction of rotated toroidal level canal**

The aim of the given project is the designing of the experimental construction, consisting of the rotating toroidal channel, thick with liquid metal. The result of the numerical calculations, made with help of Ansys 5.3, is the detecting of the toroidal channel material, and also the variant of the toroidal channel constructional execution. Low stresses in all construction elements are the main criterion of the optimal design choice.

- **Signal dynamics in wavelet phase space: the wavelet deformation algebra and its application to the analysis of seismic signals**

We want to develop theoretical and numerical tools that allows us to extract dynamical behavior from wavelet transforms corresponding to multivariate (multichannel) signals. Mathematically this amounts to the construction of an algebra of pseudo differential operators that act in wavelet space via a diffeomorphism deforming the wavelet half-plane. This technique will be applied to the problem of separating seismic signals into components, corresponding to different propagative behavior. In particular, we want to separate surface waves from body waves in seismic records. Our approach is based on the combination of (i) a recently developed polarization filter that operate entirely in the wavelet domain and (ii) an approximative description of the dispersive propagation in wavelet space.

- **Investigation of surface wave properties in mediums with microstructure**

The problem of propagation of an acoustic surface wave is considered within the framework of the asymmetric theory of elasticity (Cosserat medium). A new analytical solution of the problem in displacements is obtained. These solutions are compared with the corresponding solution for the classical elastic medium. Within the framework of the Cosserat continuum in half-space besides elliptical Rayleigh wave can be in existence the shear wave with only transversal component. Thus, in Cosserat medium the new wave mode is found out, and there is no analogue of it in classical elasticity theory.