# SIMULATION OF THE BEHAVIOUR OF LAYERED STRUCTURES UNDER EXTERNAL LOADS

***Founded in 1980.***

*Head of the research group:* ***Dmitriy Vladimirovich ARTAMONOV****, Doctor of Engineering Sciences, Professor*

The research group is based on the multilayer media theory developed by V. V. Bolotin, Academician at the Russian Academy of Sciences. The group's main research areas have been formulated by a student of Bolotin's, ***Aleksandr Nikolaevich Litvinov***, Doctor of Engineering Sciences, Professor.

***N. E. Denisov***, PhD in Engineering, Professor, and ***A. I. Voyachek***, have made a considerable contribution to the research conducted by the group.

Members of the research group: ***A. N. Litvinov***, Doctor of Engineering Sciences, Professor; A. N. Lugin, PhD in Engineering; V. V. Danilov, PhD in Engineering, Associate Professor; A. A. Avdeev, PhD in Engineering; D. A. Shevchenko, PhD in Engineering; N. V. Prokina, PhD in Engineering; G. G. Gorlov, PhD in Engineering; D. N. Shirshikov, PhD in Engineering; O. Sh. Khadi, PhD in Engineering.

The research group's main research areas are as follows:

1. Development of physical and mathematical models describing stress-strain state of layered structure composed of heterogeneous materials under mechanical, thermal, and dynamic loads.

2. Development of models, algorithms, and software for simulating and analysing the stress-strain state, primarily with applications in special-purpose mechanical and instrument engineering for defence industries. This research is aimed at improving the reliability, vibration resistance, and impact strength of products operating under complex conditions.

Key research outcomes include the development of algorithms and software for mathematical modelling of the state of layered structures in microcircuits, microsystems, multilayers boards, and tribological contacts. Special attention is given to modelling the propagation of elastic waves in piecewise inhomogeneous bodies, as well as to the development of effective methods for vibration and impact protection of components. used in special-purpose instrumentation

Mathematical modelling conducted at early stages of design enables scientifically grounded engineering and technological decisions when developing optimal structures. This significantly reduces the time and scope of testing and lowers both time and financial costs associated with product development.

Particular attention is paid to the development of products for various purposes within the framework of import substitution with enhanced vibration and impact resistance.

The research group maintains close research and creative ties with Moscow Power Engineering University, Bauman Moscow State Technical University, Penza State Technological University, Penza State University of Architecture and Construction, and the University of Technology in Iraq.

The research group conduct joint research and developments with research institutes and enterprises, including the Penza Research Institute for Electro-Mechanical Equipment, the Research Institute for Physical Measurements, Start M. V. Protsenko Production Association, Start-7 Research and Production Association, and others.

Research outcomes have been introduced into the development of special instrument engineering products to improve quality and reliability under difficult operating conditions.

***D. V. Artamonov*** and ***A. N. Litvinov*** are members of Doctor of Sciences dissertation councils and the Editorial Council of the *Mathematical Modelling in Mechanical and Instrument Engineering* Research Journal.

The research group has published over 350 research papers, including 5 monographs and 10 training manuals, and has received 7 copyright certificates.

The research group has supervised 10 PhD dissertations and 3 Doctor of Sciences publications.

**Group's members giving their presentations**

**Participants of the Conference on Models, Systems, and Networks in Engineering**