Andre Cherkaev

Professor, 1992
M.S. 1973, Leningrad Polytechnic Institute
Doctor of Sciences 1988, Leningrad State University
Professor, St. Petersburg University of Ocean
Technology, 1989-1900
Phone: (801) 581-6822
email: cherk@math.utah.edu

Activities and Awards

Mathematical Interests

The theory of structural optimization lies at a busy intersection of several mathematical disciplines---optimal control, calculus of variations, homogenization, convex analysis---and is strongly influenced by materials science. Its applications include traditional optimal design, theory of composites, phase transition in solids, ``smart'' materials, nondestructive testing, self-organization in physics, biomaterials. In practice, the process of design always includes a mysterious element: The designer chooses the construction using his/her intuition and experience. Since ancient times this technique has proved effective, and engineering landmarks from pyramids and aqueducts to ships and cathedrals were all built for centuries without mathematical or mechanical theories. From the time of Galileo and Hooke, engineers and mathematicians have developed theories to determine stresses, defections, currents, and temperature inside structures; however, this knowledge is mostly used as a checking tool, parallel with the design proper. In the past few decades, it has become possible to turn the design process into algorithms that gradually improve the initial design by a suitable variation of design variables. Optimization techniques make the design stronger, lighter, or more reliable. The problem is to lay out several materials throughout a given domain to maximize or minimize an integral functional associated with the conductive or elastic state of an assembled medium. The materials in the optimal body are mixed on an infinitely fine scale: The finer the scale, the better the construction. The optimal layout turns out to be a composite with a special structure. The challenge is to effectively describe infinitely fast oscillating layouts. A special technique---relaxation of the problem---is performed by averaging the optimal fields over an infinitesimal volume. After relaxation, the problem is addressed by standard means. The corresponding problems and techniques are discussed in my book "Variational Methods for Structural Optimization," published this year by Springer. Recently, I started to work a new intriguing project is inspired by problems in phase transition and structural design of damageable elements. It deals with dynamics and homogenized description of structures from bi-stable elements that has inner instabilities.

Selected Publications

1. A. Cherkaev. *Variational methods for structural optimization.* Springer-Verlag NY 2000.

2. A. Cherkaev. Variational Approach to Structural Optimization. In: *Structural Dynamic Systems. Computational Techniques and Optimization. Optimization Techniques. C.T Leondes- ed,* Gorgon and Breach Sc. Publ. 1999, pp. 199 - 237.

3. A. Balk, A. Cherkaev, and L. Slepyan. Dynamics of solids with non-monotone stress-strain relations. *J. Mech. Phys. Solids,* **49** (2001) 131-172.

4. A.Cherkaev and I. Kucuk. Equally stressed structures: Two-dimensional perspective. In: *Topology Optimization of Structures and Composite Contunia*, G.I.N.Rozvany and N.Olhoff eds. Kluwer 2000, 251-266.