PROGRAMA DE PÓS-GRADUAÇÃO EM
ENGENHARIA MECÂNICA E TECNOLOGIA DE MATERIAIS

Short Course

ASYMPTOTIC HOMOGENIZATION METHOD:
Basics and Applications in Mechanics of Composite Materials and Structures

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Abstract

Composite materials and structures are inhomogeneous solids with the size of a representative volume much smaller than their overall dimensions. As a result, the coefficients of equations describing mechanical behavior of composites are not constant, but rather they are rapidly varying functions. Consequently, the resulting boundary-value problems are very complex. Different analytical and numerical methods have been developed and applied in mechanics of composites in order to overcome this difficulty. Various asymptotic approaches in the analysis of composite materials of a regular structure have reached their conclusion in the method of multi-scale asymptotic homogenization. The principal result of this theory is a proof of possibility of homogenizing the composite material of a regular structure, i.e., of examining a homogeneous material with certain effective properties instead of the original inhomogeneous composite material. Asymptotic homogenization method has also indicated a way of determining the effective properties of composite material. That is accomplished through the solution of the local problems formulated on the unit cell of the composite.

Present short course will introduce the basics of the multi-scale asymptotic homogenization techniques. This method will be explained and illustrated by means of simple examples. The asymptotic homogenization technique will be further applied to the homogenization of the elasticity problem for the composite material. And the modification of this method will be presented for the analysis of thin-walled composite reinforced structures like composite plates and shells. The explicit analytical formulas will be given for the effective properties of composite materials and structures of a practical importance.

Alexander L. Kalamkarov, D.Sc, PhD, PEng, FASME, FCSME

Dr. Alex Kalamkarov is a Professor of Mechanical Engineering at the Dalhousie University in Halifax (Canada) since 1993. Dr. Kalamkarov is a founding Director of the Smart Materials Centre at the Dalhousie University since 1995. He was awarded the Doctor of Sciences (Habilitation) degree from the Academy of Sciences of the USSR in 1990 and the PhD from the Moscow Lomonosov State University in 1979. His academic career spans over 36 years in Research and University teaching.

Prior to Dalhousie University he worked in the Moscow Lomonosov State University, École Centrale Paris (France) and the University of Toronto (Canada). He was a Visiting Professor (during sabbatical leaves) at the Université Pierre et Marie Curie (Université Paris VI) and École Centrale Paris in France; University of Manchester (England); University of Tokyo (Japan); University of Hawaii (USA); Moscow State University (Russia); University of Wollongong (Australia); University of Natal (South Africa) and University of Toronto (Canada).

Research performed by Dr. Kalamkarov in Mechanics of solids, specifically in the areas of Micromechanics of composite materials and smart materials and structures is internationally recognized. He has made major contribution to the fundamental analysis, design and optimization of composite materials and smart composite structures. He developed general approaches in micromechanics of composites, established a new general theory of smart structures and developed methods of optimal design of composite materials and smart structures, developed new multi-scale asymptotic homogenization technique for the analysis of thin-walled composite structures, elaborated a novel general theory of defects in continuous media, introduced a new boundary-layer method in Fracture Mechanics of composite materials, and developed new modeling techniques for carbon nanotubes and nano-composites.

Dr. Kalamkarov made significant contribution to the design, fabrication and experimental evaluation of smart fibre-reinforced composite structures and has 2 US patents on new manufacturing technologies for smart composites.

Prof. Kalamkarov has authored more than 300 research publications, including over 130 archival refereed journal papers and 5 Research Monographs. His research results have been reported at the numerous International Conferences and Seminars. He presented 20 Invited Keynote Lectures at the International Conferences on composite materials and smart structures; developed and chaired 21 International Conferences in the area of composites and smart structures.

Dr. Kalamkarov is a member of a number of prestigious International Editorial and Advisory boards in the area of composite materials and smart structures, he has served as a Vice-President of the Canadian Society for Mechanical Engineering (CSME).

He was awarded a Fellow of the American Society of Mechanical Engineers (ASME) in 2002, and a Fellow of the Canadian Society for Mechanical Engineering (CSME) in 2001. In 2011 Prof. Kalamkarov was awarded the CANCAM (Canadian Congress of Applied Mechanics) Gold Medal for the outstanding contribution in the area of Applied Mechanics.