

The excellence course

Multiscale mathematical modeling in engineering, biology and medicine

lectured by Professor **Grigory Panasenko** (CMM and University of Lyon)

February, from 18 to 25 at Politecnico di Torino – DISMA

Short description:

The course is based on the courses given for the master and Ph.D. students in 2015-2018 at Skoltech (Moscow), University of Chile (Santiago), University of Lyon (University Jean Monnet). The course introduces main mathematical models describing mechanical behavior at microscopic level of heterogeneous media and for blood flow in network of vessels. The homogenization technique is applied for multiscale analysis of heterogeneous media. For the network of vessels the asymptotic methods (matching, boundary layers) is presented. The method of asymptotic partial decomposition of the domain defines hybrid dimension models combining one-dimensional description obtained by the dimension reduction with three-dimensional zooms. It justifies the special exponentially precise junction conditions at the interface of 1D and 3D parts. It can be applied to model the blood flow in vessels with trombs or stents.

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Program of the course

"Multiscale mathematical modeling in engineering, biology and medicine"

by Grigory Panasenko (CMM and University of Lyon)

- 1) Introduction to the main equations of mathematical physics used in the mathematical modeling and boundary and initial conditions.
 - Diffusion-convection equation
 - Viscous flows equations (Navier-Stokes equations, Stokes equations, non-newtonian flows)
 - Elasticity equations, visco-elasticity equations
 - Dirichlet's, Neumann's, Robin's and periodic boundary conditions; number of initial conditions; periodic in time problemsDerivation from physic laws (ideas) and notion of mathematical analysis (weak formulation, existence, uniqueness and stability of the solution, i.e. well-posedness).
- 2) Modeling of composite materials and meta-materials. Homogenization technique in mechanics of solids: passage from microscopic scale to the macroscopic scale.
- 3) Models of flows. Thin tube structures and multi-structures. Asymptotic analysis. Method of partial asymptotic decomposition of the domain for flows in a tube structure with rigid walls. Elastic and viscoelastic walls of the flows: special boundary conditions for the fluid.

Schedule:

Mon 18 room 7D, 10-12 + 14-16

Tue 19 room 1D, 10-12 + 14-16

Wed 20 room Buzano (DISMA) 10-13

Thu 21 room Buzano, 10-13 14-16

Fri 22 room Buzano, 10-12 + 14-16

Mon 25 room Buzano, 10-12 + 14-16

Short CV of Prof. Grigory Panasenko

Grigory PANASENKO Professor (classe exceptionnelle PREX2), Institute Camille Jordan UMR CNRS 5208, Head of the Research Federative Structure Mathematical Modelling and Decision Making (MODMAD) FED 4169, University of Lyon, 23, rue P.Michelon, 42023, St. Etienne, France tel: : (+33)477481542 (direct); (+33)477485105 (secretary) Fax : (+33)477485153 Grigory.Panasenko@univ-st-etienne.fr
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born: 12.03.1954. Graduated from Moscow State University Lomonosov, Dept.of Numerical Analysis and Informatics(1976), PH.D: 10 10 1979 Moscow State University, Doctor of Sciences Physics and Mathematics (Docteur d'Etat) 30 09 1989 Moscow State University, Assistant professor (1979-1986),Associate professor (1986-1992), Professor (1993) of Moscow State University Lomonosov (Dept. Mechmath), Professor (PR2, PR1 and PRE) of the University of Saint-Etienne (since 1993), Head of the laboratory of Mathematics of the University of Saint-Etienne (2005-2011), Head of the Research Federative Structure MODMAD (since 2011), Delegations: UMI CNRS Moscow (UMI 2615) 2014-2015, Santiago de Chili (UMI 2807) 2016-2018.Research activity: 2 monographs, 128 articles, 180 papers in proceedings, an invention. Scientific advising: 19 PH.D. thesis (1 actually) + supervising of three postdoctoral positions. Medal and Grand Prix of the USSR Academy of Sciences for young researchers: 1986 Prime d'encadrement doctoral et de recherche fellow: 1994-1998, 1998-2001,2001-2005,2005-2009,Prime d'excellence scientifique fellow: 2009-2017 Member of editorial boards of five journals on mathematics

Number of citations (source google scholar) 3668, H-index 21

5 significant publications: books

1. Bakhvalov N.S., Panasenko G.P. "Homogenization: Averaging processes in periodic media." Nauka, Moscow, 1984, 352pp. (in Russian); English transl., Kluwer, Dordrecht/Boston/London,1989, 366 pp.
2. Panasenko G.P. "Multi-Scale Modelling for Structures and Composites", Springer, Dordrecht, 2005, 398 pp.

articles

3. Panasenko G.P. "Asymptotic solutions of the elasticity theory system of equations for lattice and skeletal structures". Math. Sb.,1 992, 183, 1, 89-113 (in Russian). English transl. by AMS in Russian Acad. Sci. Sbornik Math. 75 (1993), no 1, 85-110.
4. Panasenko G.P. "Method of asymptotic partial decomposition of domain", Mathematical Models and Methods in Applied Sciences, v. 8, No 1, 1998, 139-156.
5. Panasenko G., Pileckas K., Asymptotic analysis of the non-steady Navier-Stokes equations in a tube structure.I. The case without boundary layer-in-time. Nonlinear Analysis, Series A, Theory, Methods and Applications, 122, 2015, 125-168, <http://dx.doi.org/10.1016/j.na.2015.03.008> II. General case. Nonlinear Analysis, Series A, Theory, Methods and Applications, 125, 2015, 582-607, <http://dx.doi.org/10.1016/j.na.2015.05.018>