# Design+Analysis
## VISITING LECTURE

## *Equilibrium two-phase microstructures against optimal composite microstructures*

**Prof. Alexander Freidin**
Institute for Problems in Mechanical Engineering, Russian Academy of Sciences
Peter the Great St. Petersburg Polytechnic University
St. Petersburg University

**Abstract.** We start with relating two problems arisen from different branches of mechanics of materials: construction of limiting phase transformation surfaces in strain space for stress-induced phase transitions and optimal design of two-phase 3D-composites in the sense of minimizing its energy. At first, we give a short introduction into mechanics of equilibrium interphase boundaries. Then we pass into composite materials and demonstrate that the strain energy of a two-phase linear-elastic composite is minimized by either direct or inclined simple laminates, direct or skew second-rank laminates or third-rank laminates. Following [1], we apply these results for construction of direct and reverse transformations limiting surfaces in strain space for elastic solids undergoing phase transformations. Finally, we construct stress-strain diagrams on various straining paths at which a material undergoes the phase transformation. We demonstrate that an additional degree of freedom – new phase volume fraction – may result in instability of two-phase microstructures even if the structures are energy minimizers for composites with given volume fractions of phases. This in turn may lead to incompleteness of 'monotonic' phase transformations and broken stress–strain diagrams. We study how such a behavior depends on temperature and material parameters.

[1] M.A. Antimonov, A. Cherkaev, A.B. Freidin. Phase transformations surfaces and exact energy lower bounds. *Int. J. Engineering Science*, 2016, 98, 153–182.

## Wednesday 11th January 2017 at 3 pm
## Lecture hall R3, Rakentajanaukio 4 A, Otaniemi, Espoo

*We wish you welcome – coffee at 3 pm sharp, presentation a quarter after the first dose!*

Jarkko Niiranen, Assistant Professor, Academy Research Fellow
Department of Civil Engineering, School of Engineering, Aalto University

**Design+Analysis** VISITING LECTURES target for presenting and discussing a diverse collection of topics related to C*omputational Structural Engineering* from the perspective of *Structural Analysis* and in the context of *Architectural, Industrial and Structural Design,* with a special emphasis on *Theoretical and Applied Mechanics of Solids and Structures.* Accordingly, term *design* – besides architectural, industrial and structural design – refers to designing models and methods, whereas term *analysis* refers to analyzing models and methods – besides structural analysis.