# Short Course on

# Mechanics of Random and Fractal Media

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**Course Objective**
This course gives exposition of an array of methods developed over the past few decades, and necessary for reading the literature and doing research on mechanics of random and/or fractal material microstructures. This is the grand theme of contemporary mechanics of materials, including geomechanics and biomechanics. Besides (non)linear, (in)elastic responses, various coupled field phenomena or flow in porous media, can also be handled by techniques presented here.

**Course Outline (6x2 hours)**
1. Introduction to stochastic geometric models of microstructures
2. Lattice models (periodicity *vs*. randomness, rigidity, dynamics, and optimality)
3. Mesoscale bounds for random elastic media; size of representative volume element (RVE)
4. Mesoscale bounds for random nonlinear (in)elastic media
5. Scalar/tensor random fields; fractal and Hurst effects
6. Connection to stochastic partial differential equations and stochastic finite elements (SFE)
7. Wavefronts in random media
8. Mechanics of fractal media via dimensional regularization
9. Classical (Cauchy) versus generalized (Cosserat/micropolar or nonlocal) models
10. Elastic-plastic-brittle transitions and avalanches in disordered media
11. Generalized thermoelasticity theories
12. Continuum mechanics vis-à-vis violations of the second law of thermodynamics

**Course Notes**: to be distributed

**Reference Texts** (not required):
M. Ostoja-Starzewski (2008), *Microstructural Randomness and Scaling in Mechanics of Materials*, CRC Press
J. Ignaczak and M. Ostoja-Starzewski (2010), *Thermoelasticity with Finite Wave Speeds*, Oxford Mathematical Monographs, Oxford University Press.
M. Ostoja-Starzewski, J. Li, H. Joumaa and P.N. Demmie (2013), "From fractal media to continuum mechanics," *ZAMM* **93**, 1-29

**Who Will Benefit**
Researchers in (thermo)mechanics and transport phenomena in heterogeneous random and/or fractal materials and stochastic multiscale problems

**Biosketch of Instructor**
His research interests are primarily in mechanics and transport phenomena in random/fractal media, hyperbolic thermoelasticity, micropolar theories, and biomechanics. He published 160+ journal papers and two books: 1. *Microstructural Randomness and Scaling in Mechanics of Materials*, CRC Modern Mechanics and Mathematics Series (2008); 2. *Thermoelasticity with Finite Wave Speeds*, Oxford Mathematical Monographs, Oxford University Press (2009). He also (co-)edited 10 books/journal

special issues and co-organized numerous meetings. He is/was on the editorial boards of *Journal of Thermal Stresses*, *Probabilistic Engineering Mechanics*, *Actual Problems of Aviation and Aerospace Systems*, *ASME Journal of Applied Mechanics*, *International Journal of Damage Mechanics*, and *Archive of Applied Mechanics*, *Acta Mechanica*. Also, he is Co-Editor of the CRC Modern Mechanics and Mathematics Series, and Chair Managing Editor of *Mathematics and Mechanics of Complex Systems*, (http://memocs.univaq.it/). He is Fellow of ASME, AAM, WIF, and Assoc. Fellow of AIAA.