

ME 618 Micromechanics of Materials (3-0-0-6)

Syllabus:

Introduction and review of mathematical principles and continuum mechanics. Homogenization methods for heterogeneous materials- averaging and mean-field theories, Eshelby and Mori-Tanaka approaches, self-consistent methods, cell methods, effective and apparent properties for inelastic solids, computational homogenization for highly nonlinear solids. Plasticity and microplasticity in metals - macroscale plasticity, crystal plasticity, scale size effects: strain gradient plasticity, discrete dislocation plasticity. Micromechanics of polymers and composites. Micromechanics of cellular, granular and porous materials. Multi-phase microstructures- discrete & lattice models: fundamentals, elasticity and fracture, martensitic phase transformations, microstructure evolution. Mechanics of nanostructures e.g., carbon nanotubes, graphene, polymer nanocomposites, DNA, nanoscale metallic multilayers. Practical application of micromechanics- micromechanics of manufacturing process, micromechanics of electronics systems. Discrete Dislocation Dynamics, Molecular Dynamics, Monte Carlo methods

Textbooks/References:

- [1] S. Nemat-Nasser, M. Hori, *Micromechanics: Overall Properties of Heterogeneous Materials*, North Holland; 2nd edition, 1999
- [2] T. Mura, *Micromechanics of Defects in Solids*, Springer, 1991.
- [3] S. Li and G. Wang, *Introduction to Micromechanics and Nanomechanics*, World Scientific, 2008.
- [4] R. Phillips, *Crystals, defects and microstructures: modeling across scales*, Cambridge University Press, 2001.
- [5] E.B. Tadmor and R.E. Miller, *Modeling materials: continuum, atomistic and multiscale techniques*, Cambridge University Press, 2013.
- [6] T.W. Clyne and P.J. Withers, *An Introduction of Metal Matrix Composites*, Cambridge Solid State Science Series, 1995.
- [7] L.J. Gibson and M.F. Ashby, *Cellular Solid: Structure and Properties*, Cambridge University Press, 2nd edition, 1997.
- [8] M. Šejnoha and J. Zeman, *Micromechanics in Practice*, WIT Press, 2013.