ENGR691-20 Special Topic
Micro and Nano Mechanics

TIME: 1:00-2:15 (T, Th.)

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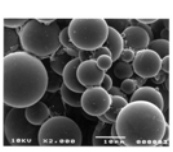
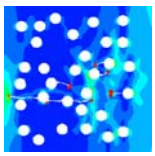
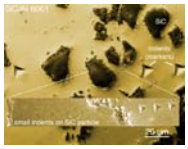
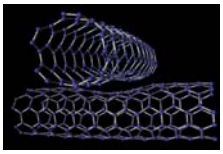
OBJECTIVE

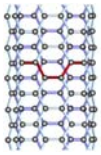
This course will introduce graduate students to different methods for evaluating mechanics of materials. Applications include, but not limited to, concrete, asphalt, soil, geological materials, polymeric composites, metal matrix composites, nano materials and nano composites.

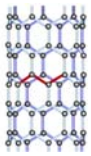

Glass Spheres

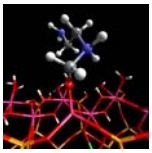

Fracture


Nano-Indentation


Carbon Nano Tubes






Clay-polymer composite

TEXT BOOKS (RECOMMENDED)

- Toshio Mura "Micromechanics of Defects in Solids (Second Edition)" Kluwer Academic Publishers
- J. Aboudi "Mechanics of Composite Materials - A Unified Micromechanical Approach." Elsevier, Amsterdam.
- G. J Weng, M. Taya., and H. Abe " Micromechanics and Inhomogeneity" Springer-Verlag.
- Christensen, "Mechanics of Composite Materials" Krieger Publishing Company.

CONTENT

- **MICROMECHANICS OF MATERTIALS**
  Microscopic analysis of cellular solids, poly-crystals and composite materials. Homogenization techniques for finding effective properties of inhomogeneous materials.
  - Deterministic Approach to Micromechanics
    - Bounds (Voigt and Russ, Hashin and higher order bounds)
    - Equivalent Inclusion Methods
      - Eshelby's Solution
      - Composite Sphere (cylinder) model
      - Self consistent
      - Differential Scheme
      - Mori-Tanaka

        - Mori-Wakashima
        - Three-phase models
        - Interface /interphase models
    - Random short fibers (mechanical, thermal and electrical properties)
    - Random cracks
  - Random Microstructure
    - Stationary Processes
    - Stochastic Processes-random Processes
    - Random Tessellation of plane (mosaic)
    - Random Fields and overall properties (mechanical, thermal and electrical)
    - Percolation, Fractals and damage (stochastic fracture)
  - Granular Media Theories

- **NANOMECHANICS**
  - Carbon Nano Tubes
    - Equivalent continuum approach
    - Quasi-continuum approach
    - Molecular Dynamics
  - CNT Composites
  - Clay
  - Polymer- Clay Composites

- **ENERGY METHODS**
  - Calculus of variations.
  - Variational principles in mechanics.
  - Approximate methods.
  - Energy criteria for stability.
  - Applications to structural dynamics.

- **THERMO-VISCOELSTICTY**
  - Thermo mechanics of solids.
  - Theory of thermoelasticity.
  - Boundary value problems in thermoelasticity.
  - Linear and nonlinear viscoelasticity.
  - Model representation.
  - Boltzmann superposition.
  - Correspondence principle.

GRADING

Home Work Assignments	40%
Midterm Exam	20%
Final Exam	20%
Project	20%