MATH 559: Mathematical Modeling of Complex Fluids

Instructor:

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Reference books:

R. G. Larson, The Structure and Rheology of Complex Fluids, Oxford (1999).
R. B. Bird, R. C. Armstrong, O. Hassager, Dynamics of Polymeric Liquids, Vols. 1 & 2, Wiley and Sons (1987).

Course Outline:

I. Introduction
1. Background and motivation
2. Review of required mathematics

II. Continuum theories
1. Oldroyd's theory for viscoelastic fluids
2. Ericksen-Leslie theory for liquid crystals
3. Viscoplastic theories

III. Kinetic theories
1. Dumbbell theory for polymer solutions
2. Bead-rod-chain theories
3. Doi-Edwards theory for entangled systems
4. Doi theory for liquid crystalline materials

IV. Heterogeneous/multiphase systems
1. Suspension theories (Einstein, Batchelor, Acrivos, etc.)
2. Kinetic theory for emulsions and drop dynamics
3. Energetic formalism for interfacial dynamics
4. Numerical methods for moving boundary problems

V. Applications
1. Polymer processing
2. Sedimentation and Fluidization
3. Bio-materials and processes: Pattern formation and self-assembly
4. Others (gels, surfactants, colloids, Marangoni flows, etc.)