Complex Fluids - ME 53700 – Fall 2021
3 credits
Class Meeting Time and Location: Online
Course Instructor: Arezoo Ardekani
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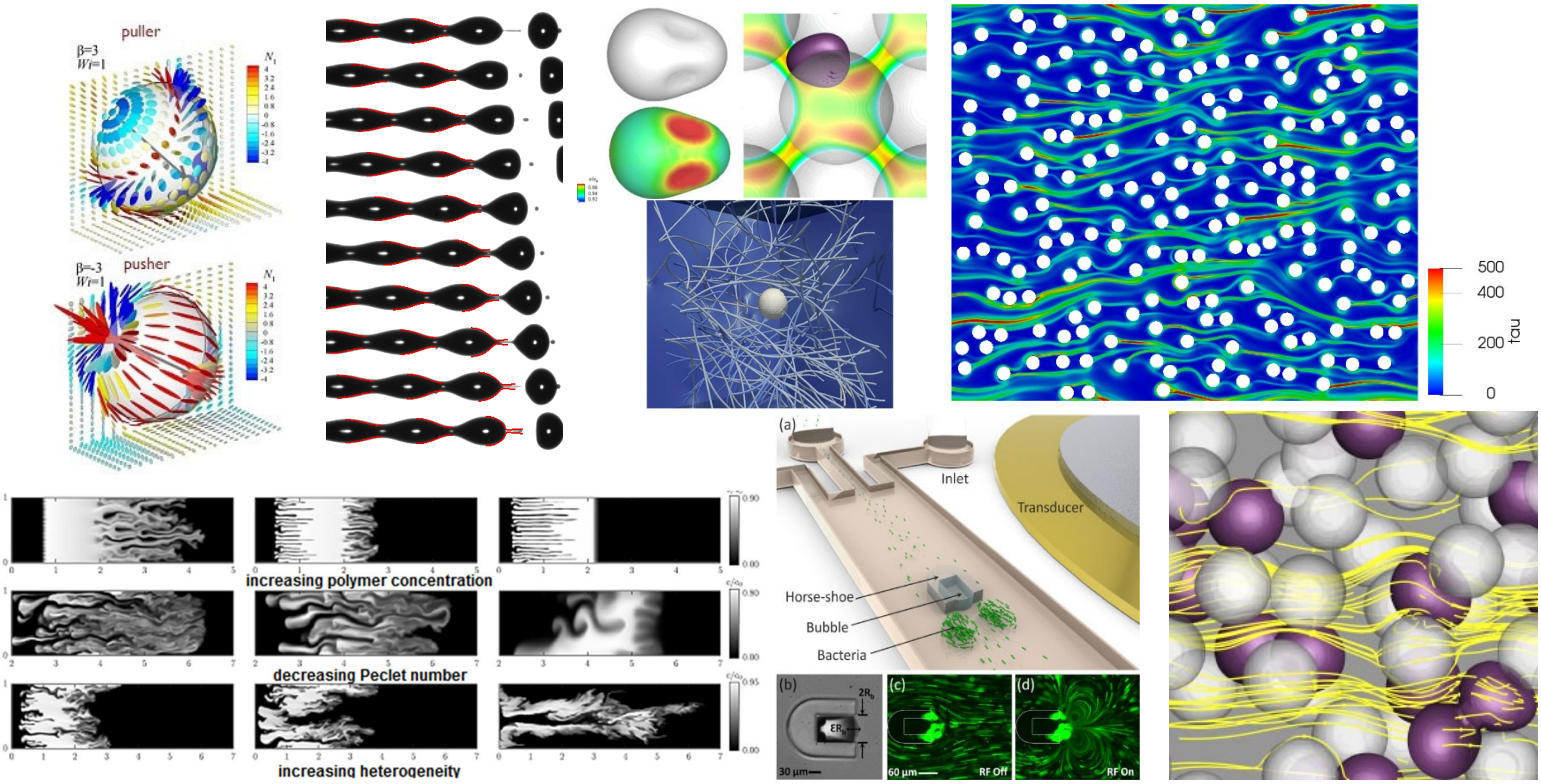
Course Description: The aim of the course is to provide a basic foundation in the fluid mechanics of viscous flows and complex fluids. Students completing this course are expected to understand the physics underlying the constitutive equations for these materials and be able to model them.

Textbook:
R.B. Bird, R.C. Armstrong, and O. Hassager, Dynamics of Polymeric Liquids, Vol. 1. Fluid Mechanics, Wiley, New York (1987), Second Edition.

Other recommended references include:
S. Kim and S.J. Karrila, Microhydrodynamics, Dover Publications Inc. (1991)

Guazzelli and Morris, A Physical Introduction to Suspension Dynamics, Cambridge University Press (2012)

M. O. Deville and T. B. Gatski, Mathematical Modeling for Complex Fluids and Flows, Springer (2012)



ME 535/597
COMPLEX FLUIDS

Course Outcomes

1. Develop a thorough understanding of complex fluids and relevant flow physics.
2. Define and describe significant properties of complex fluids.
3. Explain how properties of complex fluids are measured.
4. Understand the physics underlying the constitutive equations for complex fluids.
5. Enable continued study in advanced topics in fluid mechanics.
6. Develop the ability to critically evaluate the scientific literature on complex fluids.
7. Develop skills for scientific presentations.

Fundamental properties of viscoelastic fluids (2 weeks)

1. Introduction and examples
2. Properties of viscoelastic fluids (e.g., relaxation time, normal stress differences, yield stress, shear-thinning properties)

Classical hydrodynamics (1 weeks)

1. Mass and momentum conservation
2. Examples of viscous flow problems

Non-Newtonian fluid mechanics (4 weeks)

1. Material functions
2. Generalized Newtonian fluids
3. Examples of non-Newtonian flow problems
4. Linear Viscoelasticity

Constitutive equations (4 weeks)

1. Admissible constitutive equations
2. Ordered fluid expansions
3. Differential constitutive equations
4. Integral constitutive equations

Suspensions and emulsions (4 weeks)

1. Suspensions of particles
2. Suspensions of microorganisms
3. Emulsions
4. Breakup of liquid jets

Representative Projects

1. Create a computational, experimental or web-based tool that demonstrates or implements concepts from the course.
2. Develop a computational, experimental or web-based tool to study a complex fluid (e.g., polymeric solution, suspension, emulsion).
3. Develop a mathematical description of properties of a complex fluid.
4. Develop a mathematical solution describing flow physics for a complex fluid.