Indian Institute of Science

Mechanical Engineering
Indian Institute of Science
Bengaluru, 560 012
India

E-mail: chair.me@iisc.ac.in
URL: www.mecheng.iisc.ac.in
Telephone: +91 (80) 2293 2332 (office)

ME 202 (JAN) 3:0
Microhydrodynamics

Instructor(s): Shubhadeep Mandal

Course description:
Fundamental principles: Governing equations and boundary conditions, scaling arguments and Stokes approximation, fundamental theorems and general properties of Stokes flows, general solutions of Stokes equations. **Motion of rigid particles:** Translating and rotating particles in quiescent fluid, particles in flows, motion of anisotropic particles, weak inertial effects, phoretic motion of particles. **Motion of droplets:** Boundary conditions at fluid-fluid interface, translating droplets in quiescent fluid, droplets in flows, thermocapillary motion of droplets, surfactant-laden droplets, electrohydrodynamics of droplets, phoretic motion of droplets, applications to motion of capsules and vesicles. **Swimming cells:** Swimming at low Reynolds number, flagellar swimming, ciliary propulsion, propulsion cost and efficiency, swimming cells in flows, diffusion and noisy swimming, motion of artificial micro-swimmers.

Prerequisites:
Basic knowledge of fluid mechanics and differential equations are essential.

Resources:
1. D. Barthès-Biesel, "Microhydrodynamics and complex fluids", CRC Press, 2012.
2. S. Kim and S. J. Karrila, "Microhydrodynamics: principles and selected applications", Dover Publications, 2013.
3. E. Guazzelli and J. F. Morris, "A physical introduction to suspension dynamics", Cambridge University Press, 2011.
4. L. G. Leal, "Advanced transport phenomena: fluid mechanics and convective transport processes", Cambridge University Press, 2007.
5. Z. Zapryanov and S. Tabakova, "Dynamics of bubbles, drops and rigid particles", Springer Science & Business Media, 2013.
6. E. Lauga, "The fluid dynamics of cell motility", Cambridge University Press, 2020.

Outcomes:
After taking this course, the student will be able to
1. Formulate and investigate microscale flows involving motion of particles, droplets and swimming cells.
2. Use non-dimensionalization and scaling analysis to simplify microscale flow problems and come up with simplified mathematical models.

3. Use advanced mathematical tools such as perturbation methods to find analytical solutions to microscale flow problems.

Additional information:
This course is open to doctoral and master's students interested in microscale fluid dynamics. Undergraduate students with sufficient background can approach the instructor for permission.

Course website: https://sites.google.com/view/compbiofluid/teaching