Indian Institute of Technology Madras

AM 5014 MICROHYDRODYNAMICS

Pre-requisite: COT

Tensors
Introduction to viscous flows – Stokes' approximation; Properties of Stokes flow – Linearity, reversibility, reciprocal theorem; Single particle dynamics – Sphere in Stokes flow – Rotation, translation and extension, Fundamental singularities, Faxen's laws,; Role of fluid inertia - Oseen's approximation; Unsteady Stokes flow, Maxey-Riley equation; Brownian motion - Langevin/Fokker Planck descriptions, Fluctuation-Dissipation Theorem; Modelling of suspensions – Calculation of suspension viscosity (Einstein), Two fluid model.

Course Outcomes:

At the end of the course, the student will be able to:

1. Identify highly viscous flows and the implication of negligible fluid inertia in flow problems
2. Apply the solutions to Stokes equations to single particle dynamics
3. Calculate effective medium properties – suspension viscosity
4. Model Brownian motion of particles

INSTRUCTOR

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TEXT

A Physical Introduction to Suspension Dynamics by E. Guazzelli and J. Morris, Cambridge University Press
Microhydrodynamics, Brownian Motion, and Complex Fluids by Michael D. Graham, Cambridge University Press
Microhydrodynamics by S. Kim and S. J. Karilla

REFERENCES

An Introduction to Fluid Dynamics by G. K. Batchelor, Cambridge University Press
Colloidal Dispersions by W. B. Russel, D. A. Saville and W. R. Schowalter
Laminar Flow and Convective Transport Processes by L. Gary Leal

ASSIGNMENTS

Reading assignments should be completed before class. Homework problems will be assigned periodically in class. Completed assignments must be submitted by the beginning of class period on the day they are due. ***Group work and discussions are encouraged*** *in the solving homework problems. However, the work you submit must be your own.*

One mid-term examinations, a term project and a final examination will be scheduled.

GRADING

The course grade will be based on the following:

Assignments: 25%
Mid-term quiz: 25%
Term Project: 25%
Final Exam: 25%

'Inertial focusing' of particles in channels due to hydrodynamic forces (Segre & Silberberg *Nature* 1961/*JFM* 1962, Di Carlo *Lab on a Chip* 2009)

Experimental observation of inertial focusing, an initial uniform distribution of particles gets focussed in 4 streams downstream (Di Carlo et al. *PNAS* 2007)