

Lectures on Non-Newtonian Fluid Dynamics

Professor E John Hinch



Professor John Hinch is a Distinguished Visiting Professor in Department of Chemical Engineering in IIT Bombay. Prof Hinch would be delivering a series of lectures on Non-Newtonian Fluid Dynamics in **Room 112, Ground floor, Department of Chemical Engineering from 4:00-6:30 PM, 4-8 March, 2024**. Lecture contents are listed on the next page.

Biography

Professor John Hinch is a Professor of Fluid Mechanics in the Department of Applied Mathematics and Theoretical at the University of Cambridge. He is also a Fellow of Trinity College and a Fellow of the Royal Society. His main research interests are: micro-hydrodynamics, colloidal dispersions, flow through porous media, polymer rheology, non-Newtonian fluid dynamics, mobile particulate systems and applications of mathematics to industrial problems.

IITB: Non-Newtonian Fluid Dynamics

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1. Phenomena
2. Rheometry
3. Constitutive Equations
4. Simple flow calculations
5. Experiments
6. Numerics
7. Microstructural studies
8. Yield problems
9. Stress relaxation & Normal stresses
10. Instabilities
11. Strong flows

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1. Phenomena
 - Nonlinear flow
 - Inhibition of stretching
 - Elastic effects
 - Normal stress
2. Rheometry
 - Simple shear devices
 - Steady shear viscosity
 - Normal stresses
 - Oscillating shear
 - Extensional viscosity
 - Scalings

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3. Constitutive Equations
 - 'Simple materials'
 - Time derivatives
 - Linear viscoelasticity
 - Second-order fluid
 - Generalised Newtonian
 - Oldroyd-B
 - K-BKZ
4. Simple flow calculations
 - Pipe flow of a power-law fluid
 - Capillary rheometry
 - Bingham yield fluid in a Couette device
 - Rod-climbing of a second-order fluid
 - Unchanging flow field for a second-order fluid
 - Anisotropic converging flow
 - Spinning an Oldroyd-B fluid

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5. Experiments

- Materials
- Observations
- Practical problems

6. Numerics

- Discretisation
- Pressure
- Elliptic and hyperbolic
- Benchmarks
- Problems

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7. Microstructural studies

- Micro-Macro views
- Einstein Viscosity
- Rotation
- Deformation
- Interactions
- Model of an isolated polymer
- Model of an entangled polymer

8. Yield problems

- Yield stress
- Simple applications
- Squeeze film paradox
- Ketchup bottle and oil lines
- Open problems

9. Stress relaxation & Normal stresses

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10. Instabilities

- Spinline draw resonance
- Buckling instability
- Purely elastic instability of curved streamlines
- Coextrusion instability
- Turbulent Drag Reduction
- High-speed elastic jet

11. Strong flows

- Birefringent strand
- Wine-glass model of contraction flow
- Corner singularity
- Limited-force flows
- Success and failure of Oldroyd-B and FENE