

Course Number: 28609
Course Name: Micro and Nano Flows

Course Type:
Prerequisite:
Level: Graduate
Group: Energy Conversion

Type & Max Unit: 3
Corequisite:
First Presentation:
Last Edition:

Objectives:

Topics:

- 1. Introduction and Governing Equations**
 - 1.1- Introduction to Micro and Nano Fluid Flows
 - 1.2- New Flow Regimes in Microsystems
 - 1.3- Micro-nano Flow Characteristics
 - 1.4- The Continuum Hypothesis

- 2. Multiscale Modeling of Micro-Nano Flows**
 - 2.1- Molecular Dynamics (MD) Method
 - 2.2- Direct Simulation Monte Carlo (DSMC) Method
 - 2.3- Lattice-Boltzmann Method (LBM)
 - 2.4- Dissipative Particle Dynamics (DPD) Method

- 3. Governing Equations and Slip Models**
 - 3.1- The Basic Equations of Fluid Dynamics
 - 3.2- Compressible Flow
 - 3.3- High-Order Models

- 4. Shear-Driven Flows**
 - 4.1- Couette Flow: Slip Flow Regime
 - 4.2- Couette Flow: Transition and Free-Molecular Flow Regimes
 - 4.3- Cavity Flow

- 5. Pressure-Driven Flows**
 - 5.1- Slip Flow Regime
 - 5.2- Transition and Free-Molecular Regimes

- 6. Heat Transfer in Micro-Nano flows**
 - 6.1- Heat Transfer in Poiseuille microflows
 - 6.2- Heat Transfer in Couette microflows
 - 6.3- Nanofluid heat transfer

- 7. Electrokinetic Flows**
 - 7.1- Introduction to electrostatics
 - 7.2- Governing equations of electrokinetic flows
 - 7.3- Electroosmotic flows
 - 7.4- Electrophoresis
 - 7.5- Dielectrophoresis

8. Surface Tension-Driven Flows

- 8.1- Basic concepts and governing equations
- 8.2- Thermocapillary Pumping
- 8.3- Electrocapillary
- 8.4- Bubble Transport in Capillaries

References:

- Karniadakis, G., Beskok, A. and Aluru, N., 2005, *Microflows and nano flows, Fundamentals and simulation*, Springer, 808p.
- Kandlikar, S.G., Garimella, S., Li, D., Colin, S. And King, M.R., 2005, *Heat transfer and fluid flow in minichannels and microchannels*, Elsevier, 450 p.
- Tabeling, P., 2005, *Introduction to microfluidics*, Oxford University Press.
- Rapaport, D.C., 2004, *The art of molecular dynamics simulation*, Cambridge University Press.
- Succi, S., 2001, *The Lattice Boltzmann equation for fluid dynamics and beyond*, Clarendon Press, 288 p.