

### Introduction

Microflows and nanoflows covers the behavior, precise control and manipulation of fluids in micro and nano scale. It has emerged only in the 1990s and is a multidisciplinary field intersecting engineering, physics, chemistry, microtechnology and biotechnology and find wide applications in the development of DNA chips, micro-propulsion, micro-thermal technologies, and lab-on-a-chip technology.

### Course Objectives

- Students will be introduced to the behavior, precise control and manipulation of fluids in micro and nano scale.
- Students will be able to devise, select and use theoretical models needed for analyzing and solving complex problems encountered in micro and nano flows.

### Course Outcomes

CO1: To gain knowledge on the physics of miniaturisation.

CO2: Have exposure about electrokinetic flows and its applications.

CO3: Have exposure about fabrication techniques for micro and nano flows.

CO4: To identify, formulate, and solve interdisciplinary problems relevant for micro and nano flows.

### MODULE 1

Physics of miniaturisation – scaling laws. Microscale fluid mechanics: Intermolecular forces, Continuum assumption, Governing Equations, Gas and liquid flow, Slip Models, Shear driven flows, Pressure driven flow, Separated, internal and external flows.

### MODULE 2

Electrokinetic Flows: Electroosmotic flows Applications of electroosmotic flows. Electrophoresis Surface tension Driven flows: Mixers and chaotic advection . Simple Fluids in Nanochannels: Theories of hydrophobic surfaces. Water in nanochannels: definitions and models (atomistic models). Static behaviors- density distribution and dipole orientation, hydrogen bonding, contact angle. Dynamic behaviors – basic concepts, diffusion transport, filling and emptying kinetics.

### MODULE 3

Microfabrication techniques – Materials, Crystallography, Bulk and surface micromachining, LIGA, Packaging of microsystems.

Few Applications of microfluidics: Micro pumps, Micro Valves, Micromixers, Microreactors, NEMS, MEMS, Drug delivery, BioMEMS.

### References

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