MEC 512 Mechanics of Viscous Fluids

Spring 2019

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Lectures: Thursday 4:00- 6:50PM @ Frey Hall 222
Office Hours: Tuesdays & Thursdays 2:30-4PM @ LIGHT ENGINEERING 155

Course Topics: Fundamentals of microscopic physics of fluids. The origin and role of viscous forces in fluid flows. Physical and mathematical derivation of the Navier-Stokes equations and analytical solutions for static and dynamic problems. Newtonian and Non-Newtonian fluids. Capillary flows and wetting phenomena. Creeping flows and low Reynolds number behavior including Stokes flow, lubrication theory, imbibtion, Darcy's law for porous media, and Brownian particles in fluids. Introduction to turbulent flows and high-Reynolds number behavior including steady and unsteady external flows and boundary layers. Special topics in micro/nanofluidics and complex fluids covered if time permits. **Emphasis will be placed on the connection between macroscopic descriptions and microscopic physical phenomena.**

Credits: 3
Grade: A-F; Final exam 40% + Midterm exam 30% + Homework assignments 30%
The final exam is administered on the date assigned by the registrar office without exemptions

Tentative Lecture Schedule

week	Topic
1	**Viscous fluids: Introduction/Basic Concepts**
2	**The Navier-Stokes equations**
3	**Static equilibrium of fluids and fluid interfaces**
4	**Unidirectional flows**
5	**Laminar boundary layers & Lubrication flows**
6	**Creeping flows I**
7	**Creeping flows II**
8	**Creeping flows III**
9	**Analytical methods for fluid flow**
10	**Basic numerical solutions for fluid flow**
11	**Turbulent flows I**
12	**Turbulent flows II**
13	**Special Topics: Micro/Nanoscale flows**
14	**Special Topics: Complex fluids**

Course Learning Outcomes/Objectives

Upon completion of this course, students will be able to:

1. Understand macroscopic fluid properties such as viscosity, density, and pressure from a microscopic (atomistic) description
2. Understand the limitations of constitutive laws based on the Newtonian fluid assumption
3. Understand assumptions involved in deriving continuum-based descriptions for fluid motion

4. Understand the derivation of the Navier-Stokes equations (conservation laws for mass, momentum, and energy) for simple fluids.
5. Model and solve analytically static fluid problems involving wetting and liquid-fluid interfaces.
6. Model and solve analytically fluid flow problems for different geometries for low Reynolds numbers
7. Model fluid flow problems for simple geometries for high Reynolds numbers

Learning Objectives

The objective of this course is to (1) learn the fundamentals physics involved in modelling fluids and hydrodynamic phenomena and (2) learn analytical techniques required to solve fluid flow equations for different geometries and flow conditions. The student will learn analytical solution techniques for diverse fluid problems, including lubrication flows, boundary layers, and Stokes flow, in steady and unsteady conditions. Through learned analytical methods and basic numerical techniques presented in this course the students will be able to determine volumetric flow rates, shear and pressure drag, and lift forces for different geometric configurations. The course provides fundamental tools for professional engineers working in fluid mechanics.

DISABILITY SUPPORT SERVICES (DSS) STATEMENT

If you have a physical, psychological, medical or learning disability that may impact your course work, please contact Disability Support Services, ECC (Educational Communications Center) Building, room128, (631) 632-6748. They will determine with you what accommodations, if any, are necessary and appropriate. All information and documentation is confidential. Students who require assistance during emergency evacuation are encouraged to discuss their needs with their professors and Disability Support Services. For procedures and information go to the following website: http://www.stonybrook.edu/ehs/fire/disabilities]

ACADEMIC INTEGRITY STATEMENT:

Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty are required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Technology & Management, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty, please refer to the academic judiciary website at http://www.stonybrook.edu/uaa/academicjudiciary/

CRITICAL INCIDENT MANAGEMENT:

Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Judicial Affairs any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures.