

SYLLABUS & COURSE INFORMATION

MEC 512 – MECHANICS OF VISCOUS FLUIDS

SPRING 2025

Description

Fundamentals of the microscopic physics of fluids. The origin and role of viscosity, pressure and shear forces in fluid flows. Physical and mathematical derivations of the Navier-Stokes equations and analytical solutions for static and dynamic canonical problems. Fundamentals of Newtonian and Non-Newtonian fluids. Capillary flows, interfacial and wetting phenomena. Low-Reynolds number flows; including steady and unsteady Stokes flow, lubrication theory, imbibition, Darcy's law for porous media, and Brownian particles in fluids. Introduction to turbulent flows and high-Reynolds number flow 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 the macroscopic description and microscopic physical phenomena.

Instructor

Thomas Cubaud (thomas.cubaud@stonybrook.edu)

Office hours: Tuesday & Thursday 11:00 AM – 12:00 PM, Room 218 Heavy Eng.

Weekly schedule:

Lectures: Monday 6:30 – 9:20 pm, Frey Hall 224

Credit earned: 3 credits

Grading: Your semester letter grade will be based upon your performance in the following category:

Homework/Class assignments – 30 %

Mid-term exam – 40 %

Final project – 30 %

Tentative Schedule:

Week	Topics
1 (01/27)	Introduction, Definitions, and Basic Concepts
2 (02/03)	Conservation Laws and Fundamental Equations
3 (02/10)	Hydrostatics, Interfaces, and Wetting
4 (02/17)	Steady Unidirectional Flows
5 (02/24)	Lubrications Flows and Unsteady Flows
6 (03/03)	Dimensional Analysis and Hydrodynamic Stability
7 (03/10)	Micro-hydrodynamics and Porous Media
8 (03/17)	Spring Break
9 (03/24)	Creeping Flows: Spheres and Rods
10 (03/31)	Dynamics of Suspensions and Multiphase Flows
11 (04/07)	Boundary Layers
12 (04/14)	Mid-term Exam
13 (04/21)	Turbulent Flows
14 (04/28)	Special Topics: Electrokinetics and Micro-mixing
15 (05/05)	Project presentations

Homework assignments will be posted on Brightspace and students must upload their solutions strictly before the deadline.

Class assignments will be assigned in some of the lectures and must be completed during the class or uploaded before the following lecture.

The final project requires writing a short article resembling a peer-review publication on a topic relevant to the dynamics of fluids at large. A short presentation will be given in class.

STONY BROOK UNIVERSITY SYLLABUS STATEMENT:

Student Accessibility Support Center Statement

If you have a physical, psychological, medical, or learning disability that may impact your course work, please contact the Student Accessibility Support Center, Stony Brook Union Suite 107, (631) 632-6748, or at sasc@stonybrook.edu. They will determine with you what accommodations 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 the Student Accessibility Support Center. For procedures and information go to the following website <https://ehs.stonybrook.edu/programs/fire-safety/emergency-evacuation/evacuation-guide-disabilities> and search Fire Safety and Evacuation and 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 is 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/commcms/academic_integrity/index.html

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 Student Conduct and Community Standards any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Until/unless the [latest COVID guidance](#) is explicitly amended by SBU, during Spring 2022 "disruptive behavior" will include refusal to wear a mask during classes. For the latest COVID guidance, please refer to: <https://www.stonybrook.edu/commcms/strongertogether/latest.php>

Equivalent Opportunity/Religious Absences:

Some students may be unable to attend classes on certain days because of religious beliefs. Section 224-a of the New York State Education Law provides that:

1. No person shall be expelled from or be refused admission as a student to an institution of higher education for the reason that he or she is unable, because of his or her religious beliefs, to register or attend classes or to participate in any examination, study, or work requirements on a particular day or days.
2. Any student in an institution of higher education who is unable, because of his or her religious beliefs, to attend classes on a particular day or days shall, because of such absence on the particular day or days, be excused from any examination or any study or work requirements.
3. It shall be the responsibility of the faculty and of the administrative officials of each institution of higher education to make available to each student who is absent from school, because of his or her religious beliefs, an equivalent opportunity to register for classes or make up any examination, study, or work requirements which he or she may have missed because of such absence on any particular day or days. No fees of any kind shall be charged by the institution for making available to the said student such equivalent opportunity.
4. If registration, classes, examinations, study, or work requirements are held on Friday after 4:00 p.m. or on Saturday, similar or makeup classes, examinations, study, or work requirements, or opportunity to register shall be made available on other days, where it is possible and practicable to do so. No special fees shall be charged to the student for these classes, examinations, study, or work requirements, or registration held on other days.
5. In effectuating the provisions of this section, it shall be the duty of the faculty and of the administrative officials of each institution of higher education to exercise the fullest measure of good faith. No adverse or prejudicial effects shall result to any student because of his or her availing himself or herself of the provisions of this section.
6. Any student who is aggrieved by the alleged failure of any faculty or administrative officials to comply in good faith with the provisions of this section shall be entitled to maintain an action or proceeding in the supreme court of the county in which such institution of higher education is located for the enforcement of his or her rights under this section.
7. It shall be the responsibility of the administrative officials of each institution of higher education to give written notice to students of their rights under this section, informing them that each student who is absent from school, because of his or her religious beliefs, must be given an equivalent opportunity to register for classes or make up any examination, study, or work requirements which he or she may have missed because of such absence on any particular day or days. No fees of any kind shall be charged by the institution for making available to such student such equivalent opportunity.
8. As used in this section, the term "institution of higher education" shall mean any institution of higher education, recognized and approved by the Regents of the University of the State of New York, which provides a course of study leading to the granting of a post-secondary degree or diploma. Such term shall not include any institution which is operated, supervised, or controlled by a church or by a religious or denominational organization whose educational programs are principally designed for the purpose of training ministers or other religious functionaries or for the purpose of propagating religious doctrines. As used in this section, the term "religious belief" shall mean beliefs associated with any corporation organized and operated exclusively for religious purposes, which is not disqualified for tax exemption under section 501 of the United States code.