

Vm 520: Advanced Fluid Mechanics

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Office Hours: TBA

Who should take it? Graduate and senior undergraduate students in Mechanical/Chemical Engineering. Undergraduate students are advised to consult with the students who have had this course before, to get an idea of the level of the difficulty and expectations.

Course Description:

This course covers the fundamental mechanics of fluids **as they are treated at the senior level or in first graduate courses**. The course covers a broad area of the fundamentals of fluid mechanics before offering more advanced specialized courses to those who are specializing in various areas of fluid mechanics. The course will cover the governing equations and conservation laws, several ideal flows, viscous flows of incompressible fluids, boundary layers, surface waves, etc.

Prerequisite:

- Undergraduate fluids mechanics, thermodynamics and heat transfer
- Strong mathematical background, including calculus, vector algebra and tensor analysis
- Motivation to learn and digest underlying physics

Course Syllabus:

1. Fundamentals
 - a. Statistical and continuum methods
 - b. Eulerian and Lagrangian Coordinates
 - c. Material derivative
 - d. Control volumes
 - e. Reynolds' transport theorem
2. Governing equations
 - a. Conservation of mass
 - b. Conservation of momentum
 - c. Deformation (rotation and rate of shear)
 - d. Constitutive equations
 - e. Viscosity coefficients
 - f. Navier-Stokes equations

- g. Boundary conditions
 - h. Conservation of energy
 - i. Thermal and mechanical energy equations
 - j. Special forms of governing equations
- 3. Potential flows of 2D and 3D basic cases
 - 4. Surface waves on shallow and deep liquid layers
 - 4. Exact solutions for viscous incompressible fluids
 - a. Couette Flow
 - b. Poiseuille Flow
 - c. Stokes' First Problem
 - d. Stokes' Second Problem
 - 5. Boundary layers

Tentative Lectures:

Week 1: Fundamentals

Week 2-3: Governing equations

Week 4-5: Potential flows

Week: 6-8: Surface waves

Week 9-10: Exact solutions for classic viscous flows

Week: 11-12: Boundary layer

Week 13: Final exam

Grading Policy:

Assignments: 10%

Midterm Exam: 40%

Final Exam: 50%

Textbook/Required material:

Fundamental Mechanics of Fluids, Third Edition, I. G. Currie

Marcel Dekker INC. New York, Basel; Available on SJTU on-line library:

Honor Code:

JI Honor code + common sense

No electronic device is allowed in the class.