

ME 211 - Fluid Mechanics I

Spring Semester, 2004

www.uic.edu/classes/me/me211

Instructor: Constantine M. Megaridis (cmm@uic.edu), Professor

Catalog

Description: 3 Hours. Fluid properties, dimensional analysis, statics and kinematics, conservation equations, inviscid and incompressible flows, Bernoulli's equation, integral momentum theorems, viscous flows, qualitative analysis of turbulent flows and boundary layer theories. Prerequisites: MATH 220, PHYS 141.

Textbook: *Fluid Mechanics*, 5th edition, F. M. White, Mc Graw Hill, 2003.

Laboratory Manual, C. M. Megaridis and W. J. Minkowycz, 1999. Will be posted on web site (password-protected).

Objectives: This is an *introductory* course in the mechanics of fluid motion. It is designed to establish fundamental knowledge of basic fluid mechanics and address specific topics relevant to technological applications involving fluids. Also, to introduce relevance of fluid dynamics to engineering design. The course includes a laboratory component as well as important applications such as flow in pipes, flow over airfoils and flow in channels. Students successfully completing this course are expected to: be able to perform basic calculations for design and analysis of simple systems involving fluid motion; be familiar with standard experimentation tools in the field; be aware and appreciative of the importance of fluid processes in the well being of the society; gain experience working in groups; be able to compose clear and effective engineering reports.

Prerequisites by topic:

1. Basic knowledge of statics and dynamics of solid bodies.
2. Mathematics including differential and integral calculus, as well as differential equations.

Nature of Instruction:

Lectures (in 1023 ERF), demonstrations, video and labs (all in 3280 SEL)

Topics covered:

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| 1. Basic concepts | 2 hours |
| 2. Fluid statics (Laboratory in fluid properties and statics) | 2 hours |
| 3. Solid body rotation (Laboratory in liquid rotation) | 1 hour |
| 4. Control volume approach | 2 hours |
| 5. Equations of motion (Laboratories on Bernoulli's equation and momentum equations) | 5 hours |
| 6. Dimensional analysis and similitude (Laboratory on drag and dimensional analysis) | 3 hours |
| 7. Inviscid flows | 2 hours |

8. Viscous flow in pipes (Laboratory on friction loss in viscous pipe flow)	4 hours
9. Boundary layer theory	2 hours
10. Flow over immersed bodies	3 hours
11. Open channel flows (Laboratory on overflow spillway and hydraulic jump)	2 hours
12. Laboratory	30 hours
13. Examinations	2 hours
14. Final examination	2 hours
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Total	62 hours

Computer usage:

1. Homework assignments. Elective use of spreadsheets, mathematics applications and programming languages.
2. Laboratory data reduction. Repetitive calculations of laboratory measurements are handled through spreadsheet analysis and plotting.

Laboratory projects:

1. Demonstration: Fluid properties. The purpose of these demonstrations is to display some of the fluid properties that are important in the study of fluid mechanics. These properties include pressure, buoyancy, capillarity, surface tension, density, specific gravity, and viscosity. A rigorous attempt is made to bring out the physical and engineering importance of such phenomena.
2. Demonstration: Flow visualization using a smoke tunnel. This experiment features a small, low-speed wind tunnel capable of tracing selected velocity fields with smoke. The flow patterns around various solid models are observed using streaklines and discussed physically.
3. Experiment #1: Rigid-body rotation of an incompressible fluid. In this experiment, the relationship between the shape of the curved free surface and the angular velocity of a liquid undergoing rigid-body rotation in a cylindrical tank is investigated.
4. Experiment #2: Fluid dynamic drag and relevant parameters. This experiment examines some fundamental concepts relevant to the gravitational settling of a solid sphere falling within a liquid medium. The main goal of the experiment is to measure the drag force exerted on the sphere and examine the dependence of the drag coefficient on the associated Reynolds number.
5. Experiment #3: One dimensional Bernoulli equation: Flow metering device. In this experiment, variations of static pressure and fluid flow velocity in a Venturi tube are investigated. The main goal of the experiment is to utilize the Venturi meter to measure liquid flow rate, and provide comparisons between experiment and theory via the Bernoulli equation.
6. Experiment #4: Integral momentum equation: Impact of a jet. In this experiment, the force generated by a cylindrical water jet as it strikes a flat plate or a hemispherical cup is measured and compared with the force predicted using the integral momentum equation.

7. Experiment #5: Friction loss in flow through pipes. In this experiment, the laws governing friction losses in pipe flows are studied by measuring the friction factor as a function of the Reynolds number. Both laminar and turbulent flows are investigated.
8. Experiment #6: Overflow spillway and hydraulic jump. In this experiment, the physical and mathematical laws governing fluid flow in hydraulic channels are studied. Comparisons are made between experiment and theory. The concept of energy dissipation is introduced.

Grading: Out-of-class problems (homework) = 15%; laboratories = 25%; quiz = 10%; midterm exam = 20%; final exam = 30%

Teaching Assistants: David Lee (jlee88@uic.edu), Mandar Deshpande (mdeshp1@uic.edu), Peyman Davoudabad (mdavou1@uic.edu)

Office Hours: Lecture material (CMM), M 3-4pm, W 1-2pm in 3035ERF

Homework and lab material (TA):

M 2-3pm, Tue and Thu 3:30-5pm, W 12-1pm, F 3:30-4:30pm
in 3280SEL

Reference Books (useful, but not required):

1. P.M. Gerhart, R.J. Gross and J.I. Hochstein, "Fundamentals of Fluid Mechanics," 2nd Edition (1992)
2. B. R. Munson, D. F. Young and T. H. Okiishi, "Fundamentals of Fluid Mechanics," 4th Edition (2002)
3. M.C. Potter and D.C. Wiggert, "Mechanics of Fluids," 2nd edition, (1997)
4. V.L. Streeter, E.B. Wylie and K.W. Bedford, "Fluid Mechanics," 9th edition (1998)

Other:

No formal oral presentations are given by the students in this course. The students perform the laboratory experiments, thus they need to communicate effectively with the laboratory instructor. Laboratory reports may give students feedback concerning communication skills (format, clarity, etc.) beyond the technical content.

Attendance of the lectures is strongly recommended. Late homework/report submissions will be accepted only under exceptional circumstances. Make-up exams (written or oral) may be allowed in case of illness and advance notice (call Prof. Megaridis at 312 996-3436).