Fundamentals of Fluid Dynamics

(流體力學導論)

Lecturer: U Lei (李雨)
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Time: 13:30 – 14:30, Monday; 13:00 – 15:00, Wednesday
Place: Room 111, IAM Building
Office hours: 13:00 – 14:30, Monday; 13:00-14:30 Wednesday

Teaching assistant: Harry Lin (林柏宇)
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Course Materials

Lecture notes:

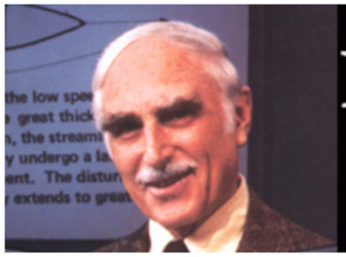
The course notes and the related materials can be downloaded from the NTUCOOL website.

NCFMF films: (25 movies)

By the National Committee for Fluid Mechanics Films under a grant from the National Science Foundation of USA.

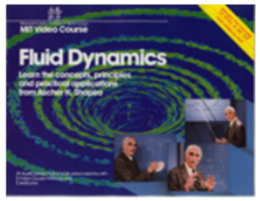
You may download the illustration (pdf) files for separated movies, and also watch the moves online via the following website:

http://web.mit.edu/hml/ncfmf.html

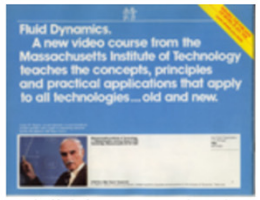


National Committee for Fluid Mechanics Films

In 1961, Ascher Shapiro founded the National Committee for Fluid Mechanics Films (NCFMF) in cooperation with the Education Development Center and released a series of 39 videos and accompanying texts which revolutionized the teaching of fluid mechanics. MIT's iFluids program has made a number of the films from this series available on the web. (Download / Purchase information.)



The preface to *Illustrated Experiments in Fluid Mechanics: The NCFMF Book of Film Notes* can be found below.



(Click images to enlarge)

Complete film notes for the NCFMF movies

Ascher Shapiro's Obituary

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Aerodynamics Generation of Sound	TechTV	YouTube	Film Notes
Boundary Layer Control	TechTV		
Cavitation	TechTV	YouTube	Film Notes
Channel Flow of a Compressible Fluid	TechTV	YouTube	Film Notes
Deformation of Continuous Media	TechTV	YouTube	Film Notes
Eulerian Lagrangian Description	TechTV	YouTube	Film Notes
Flow Instabilities	TechTV	YouTube	Film Notes
Flow Visualization	TechTV	YouTube	Film Notes
Fluid Dynamics of Drag Part I	TechTV	YouTube	
Fluid Dynamics of Drag Part II	TechTV	YouTube	
Fluid Dynamics of Drag Part III	TechTV	YouTube	
Fluid Dynamics of Drag Part IV	TechTV	YouTube	
Fundamental Boundary Layers	TechTV	YouTube	Film Notes
Low Reynolds Number Flow	TechTV	YouTube	Film Notes
Magnetohydrodynamics	TechTV	YouTube	Film Notes
Pressure Fields and Fluid Acceleration	TechTV	YouTube	Film Notes
Rarefied Gas Dynamics	TechTV	YouTube	Film Notes
Rheological Behavior of Fluids	TechTV	YouTube	Film Notes
Rotating Flows	TechTV	YouTube	Film Notes
Secondary Flow	TechTV	YouTube	Film Notes
Stratified Flow	TechTV	YouTube	Film Notes
Surface Tension in Fluid Mechanics	TechTV	YouTube	Film Notes
Turbulence	TechTV	YouTube	Film Notes
Vorticity, Part 1	TechTV	YouTube	Film Notes
Vorticity, Part 2	TechTV	YouTube	Film Notes
Waves in Fluids	TechTV	YouTube	Film Notes

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Contents

(1) Introduction (6 hours)
(2) Physical and mathematical formulations of fluid mechanics (12 hours)
(3) Some exact solutions for illustrating various terms of the equations (5 hours)
(4) The flow physics from small to large Reynolds numbers (1 hours)
(5) Low Reynolds number flows (5 hours)
(6) Potential flows (6 hours)
(7) Laminar boundary layer theory (5 hours)
(8) General discussion on other topics in fluid mechanics (3 hours)

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Grading Policy

1. Homework (20%)
2. Midterm examination (40%) --- Topic (1) to (3)
3. Final Examination (40%) --- Topic (4) to (7)

References

(1) Batchelor, G. K., "An introduction to fluid dynamics," Cambridge University Press, 1967.

(2) Currie, I. G., "Fundamental mechanics of fluids," 3rd ed., Marcel Dekker, New York, 2003.

(3) Landau, L. D. and Lifshitz, E. M., "Fluid Mechanics," Pergamon, 1959.

(4) Ligget, J. A., "Fluid mechanics," McGraw-Hill, 1994.

(5) Panton, R. L., "Incompressible flows," 4th ed., Wiley, 2013.

(6) Schlichting, H., "Boundary layer theory," 7th ed., McGraw-Hill, 1979.

(7) White, F. M., "Viscous fluid flow," 3rd ed., McGraw-Hill, 2006.

(8) Yih, Chia-Shun, "Fluid Mechanics," West River Press, Ann Arbor, Michigan, 1977.

(9) Munson et al., “Fundamentals of Fluid Mechanics,” 7th ed., Wiley, 2013. (Undergraduate text)

The NCFMF film

- **NCFMF** – The National Committee for Fluid Mechanics Films under a grant from The National Science Foundation of USA.
- **Committee members:**

Frederick H. Abernathy, Harvard University (Chairman 1970-1971)

Arthur E. Bryson, Jr., Harvard University (Chairman, 1965-1968)

Donald Coles, California Institute of Technology

Stanley Corrsin, The Johns Hopkins University

Dave Fultz, University of Chicago

Robert A. Gross, Columbia University

Stephen J. Kline, Stanford University

Erik L. Mollo-Christensen, MIT (Chairman, 1968-1970)

Walter L. Moore, University of Texas

Ascher H. **Shapiro**, MIT (Chairman, 1961-1965, 1971-)

Hsuan Yeh, University of Pennsylvania

The NCFMF film - 1

(1) Eulerian and Lagrangian description (28 minutes)
(John L. Lumley, Pennsylvania State University; 1968)
(2) Flow visualization (31 minutes)
(S. J. Kline, Stanford University; 1963)
(3) Deformation of continuous media (38 minutes)
(John L. Lumley, Pennsylvania State University; 1963)
(4) Rheolgical behavior of fluids (22 minutes)
(Hershel Markovitz, Mellon Institute; 1965)
(5) Pressure field and fluid acceleration (31 minutes)
(Ascher H. Shapiro, MIT; 1963)
(6) Cavitation (32 minutes)
(Phillip Eisenberg, Hydronautics Incorporated; 1968)

The NCFMF film - 2

(7) Vorticity (44 minutes)
(Ascher H. Shapiro, MIT; 1961)
(8) Low Reynolds number flows (33 minutes)
(Geoffrey I. Taylor, Cambridge University; 1967)
(9) Fundamentals: Boundary layer (24 minutes)
(Frederick Abernathy, Harvard University; 1968)
(10) Boundary layer control (26 minutes)
(David C. Hazen, Princeton University; 1965)
(11) Secondary flow (30 minutes)
(Edward S. Taylor, MIT; 1965)
(12) Flow instabilities (27 minutes)
(Erik L. Mollo-Christensen, MIT; 1968)

The NCFMF film - 3

(13) Turbulence (29 minutes)
(Robert W. Stewart, University of British Columbia; 1969)
(14) Fluid dynamics of drag – Part 1 – Some curious experiment (24 minutes) – (Ascher H. Shapiro, MIT; 1960)
(15) Fluid dynamics of drag – Part 2 – Fundamental concepts (32 minutes) – (Ascher H. Shapiro, MIT; 1960)
(16) Fluid dynamics of drag – Part 3 – The law of drag in fluids (37 minutes) – (Ascher H. Shapiro, MIT; 1960)
(17) Fluid dynamics of drag – Part 4 – How to reduce drag (24 minutes) – (Ascher H. Shapiro, MIT; 1960)

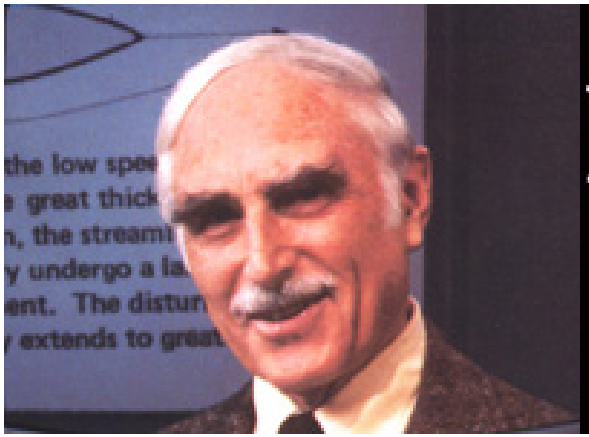
The NCFMF film - 4

(18) Rotating flows (29 minutes)
(Dave Fultz, University of Chicago; 1969)
(19) Stratified flow (27 minutes)
(Robert R. Long, The Johns Hopkins University; 1968)
(20) Surface tension in fluid mechanics (24 minutes)
(Lloyd Trefethen, Tufts University; 1964)
(21) Waves in fluids (33 minutes)
(Arthur E. Bryson; Harvard University; 1964)
(22) Aerodynamic generation of sound (44 minutes)
(John E. Flowcs Williams and M. James Lighthill,
Imperial College of Science & Technology,
University of London; 1969)

The NCFMF film - 5

(23) Channel flow of a compressible fluid (29 minutes)
(Donald Coles, California Institute of Technology; 1967)
(24) Rarefied gas dynamics (33 minutes)
(Frederick S. Sherman and Franklin Hurlbut,
University of California at Berkeley; 1968)
(25) Magnetohydrodynamics (30 minutes)
(J. Arthur Shercliff, Warwick University, England; 1967)

Watch movies: http://web.mit.edu/hml/ncfmf.html



National Committee for Fluid Mechanics Films

"The concept that brought the NCFMF into existence was the conviction that films would provide a convenient, economic, and powerful way of filling a serious educational gap. On the one hand are the **concrete, experimental, perceptual phenomena** of the real world of fluid motion. On the other hand is the **abstract, mathematical, conceptual treatment** of the subject in textbooks and classroom lectures."

Quoted from http://web.mit.edu/hml/ncfmf.html

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Time changes

- The classes on Wednesday will be ended at 12:35 instead of 12:10, so that we have more time for watching the NCFMF movies together, and have some discussion.