Internal Fluid Dynamics
AE 510

CHAPTER 0
–
Course Objectives and Syllabus

by
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Instructor

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Lecture webpage:



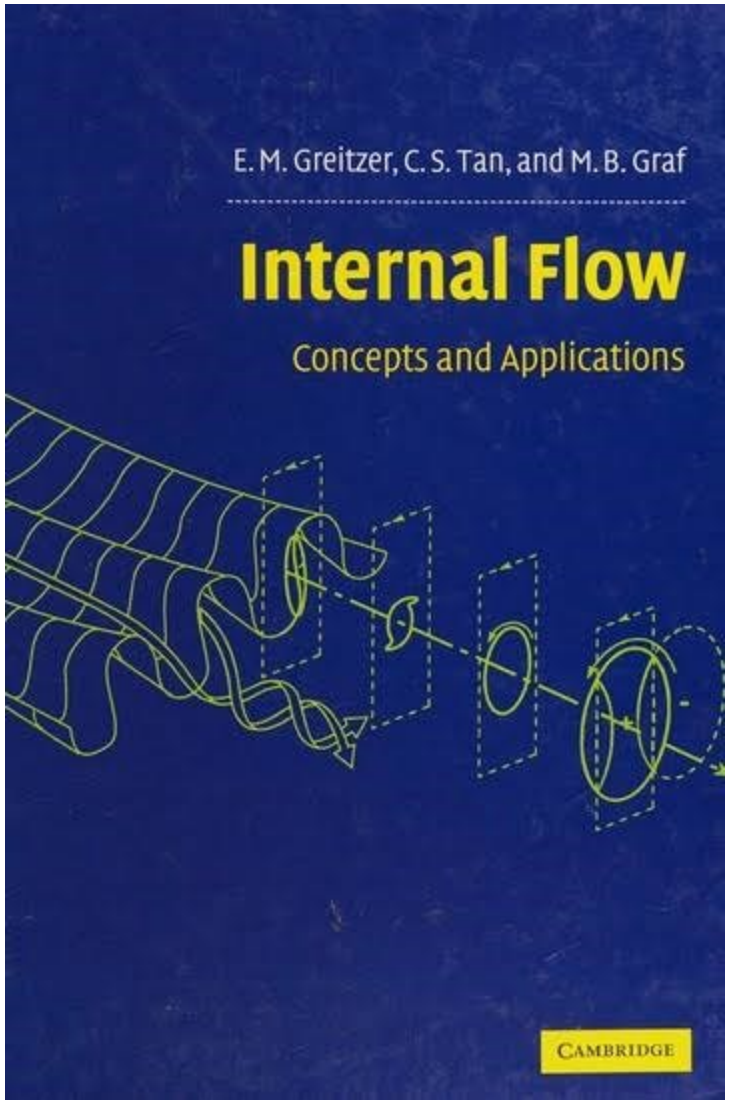
Class Information

Class Hours: Thursday – 13.30-16.00 (A01)

3-0 credit

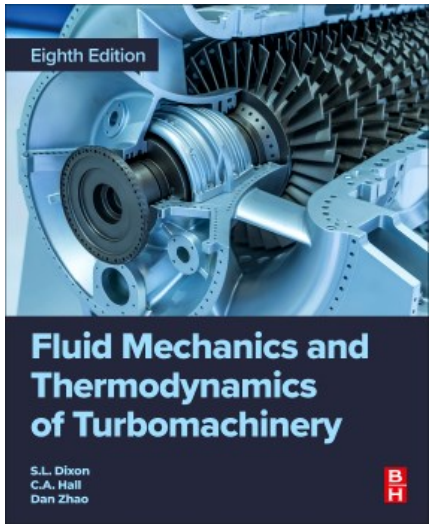
Compulsory Textbook

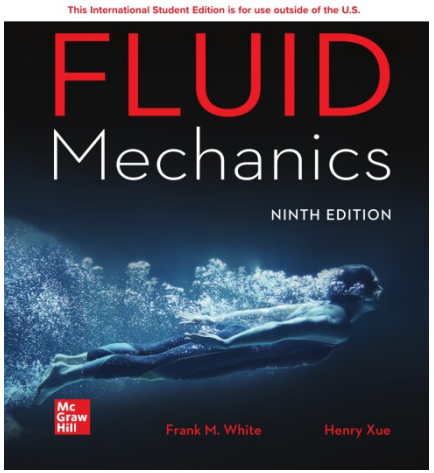
- M. Greitzer – Internal Flow: Concepts and Applications



Reference Textbooks

- Dixon, S. L., Hall, C. A., & Zhao, D. (2025). Fluid Mechanics and Thermodynamics of Turbomachinery (8th ed.). Butterworth-Heinemann.
- White, F. M., & Xue, H. (2021). Fluid Mechanics (9th ed.). McGraw Hill.





Objectives of AE510 Course

- To develop rigorous physical understanding and modeling capability for complex internal flows occurring in turbomachinery, propulsion systems, ducts, rotating passages, and industrial fluid devices, with emphasis on rotationality, viscosity, compressibility, secondary flow structures, losses, and unsteady phenomena.

AE510 Course Content

- Internal fluid flows in compressors, turbines, ducts, and propulsion systems are introduced together with their governing conservation equations.
- Viscous, compressible, rotational, and boundary-layer effects in internal flows are analyzed using fluid mechanics principles.
- Vorticity dynamics, secondary flows, and loss-generation mechanisms in turbomachinery are examined.
- Flow behavior in rotating passages, unsteady internal flows, and turbomachinery instabilities such as rotating stall and surge are studied.
- Basic turbulence modeling and CFD applications for the analysis of complex internal flows are presented.

AE 510 Internal Fluid Mechanics Lecture

- Background needed:
  - Undergraduate Numerical Analysis and Fluid Mechanics
  - Undergraduate Aerodynamics I and II
  - Basic computing skills (C, Python or MATLAB)

Assessment (LOOK OUT !)

- Homeworks
- Midterm
- Project
- Final Exam

Assessment (LOOK OUT !)

- Homeworks
  - 4 homeworks will be given. All details will be on the given PDF file.

Assessment (LOOK OUT !)

- Midterm:

One midterm will be given. It will be take-home exam. It will be hand-written solution of the subject related to lecture notes.

Assessment (LOOK OUT !)

- Project:

An internal fluid flow problem will be given. The problem will be solved by coding (Python, C or Matlab) The resulting images and tables will be asked for. The students will have a limited time for powerpoint presentations of their results. The students' report and PPT presentation as 10% each (a total of 20%).

Assessment (LOOK OUT !)

- Final Examination:

A final exam will be given according to the school schedules. The exam will be two parts:

Part-1: Multiple-choice type. (Closed book, closed notes)

Part-2: Problems. (Open textbook, open notes)

Assessment (LOOK OUT !)

- Final Grades:

Homeworks	20	%
Midterm (Take home)	20	%
Project (Presentation)	20	%
Final Exam	40	%
Total	100	%

Tentative Schedule (Titles can change)

Week-1 (24th Sep): Introduction (Chapter 0)
Week-2 (1st Oct): Introduction to Internal Flows and Governing Equations – HW1 will be given, report to be submitted next week.
Week-3 (8th Oct): Fundamental Equations of Fluid Motion
Week-4 (15th Oct): Thermodynamics, Compressibility, and Flow Similarity – HW2 will be given, report to be submitted next week.
Week-5 (22th Oct): Basic Internal Flow Concepts and Incompressible Flow
Week-6 (29th Oct): Republic Day (29 Ekim Cumhuriyet Bayramı) HOLIDAY
Week-7 (5nd Nov): MIDTERM -TAKE HOME- EXAM WILL BE SHARED ON LECTURE SITE. Take home exam will be finished by students till next week AND SUBMITTED AS A HANDWRITTEN FILE AT THE START OF WEEK-8.
Week-8 (12th Nov): Quasi-One-Dimensional Compressible Flow & Shock Waves, Boundary Layers, and Flow Separation
Week-9 (19th Nov): Vorticity and Circulation Fundamentals & Vorticity Generation and Transport Mechanisms – HW3 will be given, report to be submitted next week.
Week-10 (26th Nov): Boundary Layers
Week-11 (3rd Dec): Free Shear Flows & Loss Mechanisms and Entropy Generation – PROJECTS will be given, report and presentations to next week.
Week-12 (10th Dec): PROJECT PRESENTATIONS
Week-13 (17th Dec): Unsteady Flow Phenomena and Instabilities – HW4 will be given, report to be submitted next week.
Week-14 (24th Dec): Rotating Flows and Swirling Motion & Secondary Flows and Three-Dimensional Effects