

Semester: Spring 2023
Course: MEC 393, Engineering Fluid Mechanics

Instructor:

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Office Phone: (631)632-8493;

Lectures: Tuesdays, Thursdays. 01:15 – 02:35 PM,
Frey Hall 305

Prerequisite: Fluid Mechanics 1 MEC 364

Textbook: Introduction to Fluid Mechanics by Fox and McDonald's, John Wiley & Sons, 8th, ISBN-13 9780470547557, ISBN-10 0470547553

Course Description:

Flow around immersed bodies; drag and lift. Introduction to boundary layer theory. Compressible flow; one-dimensional isentropic flow, normal and oblique shocks; Prandtl-Meyer flow; Rayleigh and Fanno flow.

Course Learning Objectives:

By the end of the course students will be able to:

- compute boundary layer thicknesses and associated properties using Blasius and momentum integral methods
- determine lift and drag of simple bodies
- analyze one-dimensional compressible fluid flow systems, analyze simple two-dimensional shock waves

Syllabus

Topics: (numbers of class lectures are approximate and might change as class progresses)

CHAPTER 8 INTERNAL INCOMPRESSIBLE VISCOUS FLOW

8.1 Introduction

- Laminar versus Turbulent Flow
- The Entrance Region

PART A. FULLY DEVELOPED LAMINAR FLOW

8.2 Fully Developed Laminar Flow between Infinite Parallel Plates

- Both Plates Stationary
- Upper Plate Moving with Constant Speed, U

8.3 Fully Developed Laminar Flow in a Pipe

PART B. FLOW IN PIPES AND DUCTS

8.4 Shear Stress Distribution in Fully Developed Pipe Flow

8.5 Turbulent Velocity Profiles in Fully Developed Pipe Flow

- Energy Considerations in Pipe Flow
- Kinetic Energy Coefficient
- Head Loss

8.7 Calculation of Head Loss

- Major Losses: Friction Factor
- Minor Losses
- Pumps, Fans, and Blowers in Fluid Systems
- Noncircular Ducts

8.8 Solution of Pipe Flow Problems

- Single-Path Systems
- *Multiple-Path Systems

PART C. FLOW MEASUREMENT

8.9 Direct Methods

8.10 Restriction Flow Meters for Internal Flows

- The Orifice Plate
- The Flow Nozzle
- The Venturi
- The Laminar Flow Element

8.11 Linear Flow Meters

8.12 Traversing Methods

CHAPTER 9 EXTERNAL INCOMPRESSIBLE VISCOUS FLOW

PART A. BOUNDARY LAYERS

9.1 The Boundary-Layer Concept

9.2 Boundary-Layer Thicknesses

9.3 Laminar Flat-Plate Boundary Layer: Exact Solution

9.4 Momentum Integral Equation

9.5 Use of the Momentum Integral Equation for Flow with Zero Pressure Gradient

- Laminar Flow
- Turbulent Flow
- Summary of Results for Boundary-Layer Flow with Zero Pressure Gradient

9.6 Pressure Gradients in Boundary-Layer Flow

PART B. FLUID FLOW ABOUT IMMERSED BODIES

9.7 Drag

- Pure Friction Drag: Flow over a Flat Plate Parallel to the Flow
- Pure Pressure Drag: Flow over a Flat Plate Normal to the Flow
- Friction and Pressure Drag: Flow over a Sphere and Cylinder
- Streamlining

9.8 Lift

CHAPTER 12 INTRODUCTION TO COMPRESSIBLE FLOW /657

12.1 Review of Thermodynamics

12.2 Propagation of Sound Waves

- Speed of Sound
- Types of Flow—The Mach Cone

12.3 Reference State: Local Isentropic Stagnation Properties

- Local Isentropic Stagnation Properties for the Flow of an Ideal Gas

12.4 Critical Conditions

CHAPTER 13 COMPRESSIBLE FLOW

13.1 Basic Equations for One-Dimensional Compressible Flow

13.2 Isentropic Flow of an Ideal Gas: Area Variation

- Subsonic Flow, $M < 1$
- Supersonic Flow, $M > 1$
- Sonic Flow, $M = 1$
- Reference Stagnation and Critical Conditions for Isentropic Flow of an Ideal Gas
- Isentropic Flow in a Converging Nozzle
- Isentropic Flow in a Converging-Diverging Nozzle

13.3 Normal Shocks

- Basic Equations for a Normal Shock
- Fanno and Rayleigh Interpretation of Normal Shock
- Normal-Shock Flow Functions for One-Dimensional Flow of an Ideal Gas

13.4 Supersonic Channel Flow with Shocks

- Flow in a Converging-Diverging Nozzle
- Supersonic Diffuser (on the Web)
- Supersonic Wind Tunnel Operation (on the Web)
- Supersonic Flow with Friction in a Constant-Area Channel (on the Web)
- Supersonic Flow with Heat Addition in a Constant-Area Channel (on the Web)

13.5 Flow in a Constant-Area Duct with Friction

- Basic Equations for Adiabatic Flow
- Adiabatic Flow: The Fanno Line
- Fanno-Line Flow Functions for One-Dimensional Flow of an Ideal Gas
- Isothermal Flow (on the Web)

13.6 Frictionless Flow in a Constant-Area Duct with Heat Exchange

- Basic Equations for Flow with Heat Exchange
- The Rayleigh Line
- Rayleigh-Line Flow Functions for One-Dimensional Flow of an Ideal Gas

13.7 Oblique Shocks and Expansion Waves

- Oblique Shocks
- Isentropic Expansion Waves

CHAPTER 10 FLUID MACHINERY

10.1 introduction and Classification of Fluid Machines

- Machines for doing Work on a Fluid
- Machines for Extracting Work (Power) from a Fluid

10.2 Turbomachinery Analysis

- The Angular-Momentum Principle: The Euler Turbomachine Equation
- Velocity Diagrams
- Performance Hydraulic Power
- Dimensional Analysis and Specific Speed

10.3 Pumps, Fans and Blowers

- Application of Euler Turbomachine Equation to Centrifugal Pumps
- Application of the Euler Equation to Axial Flow Pumps and Fans
- Performance Characteristics
- Similarity Rules
- Cavitation and Net Positive suction Head
- Pump Selection: Applications to Fluid Systems
- Blowers and Fans

Announcements: Each student will be responsible for knowledge of all scheduling and announcements with regards to this course. Each student is advised to check course web pages regularly.

The homework should be viewed as a tool to help you understand the material. In that sense, your success in this course will depend highly upon your completing homework assignments. If you feel you need additional practice, you should try to solve additional problems in the textbook. Collaboration on homework is allowed. A lot of valuable insight can be gained from interaction with your classmates. However, blindly copying homework will be treated as academic dishonesty.

Please adhere to the following guidelines. They will be strictly enforced:

Typically five to six problems will be assigned after every Thursday lecture and are due within one week of assignment.

Homework will be accepted only before the due date. All homeworks must be submitted in class before lecture begins.

No Late homework will be accepted.

Homework must be boldly shown including all steps and procedures. Homeworks will be accepted on any form of a paper and pen

Write your name, ID, course and homework number on a cover page attached to your homework solutions

Make sure you numbered the question and show all your procedures

Graded homework shall be collected from my office.

The solutions to the homework problems may not be posted on the brightspace.

Online quizzes will be assigned after completion of every chapter and you must answer all the 50 multiple choice questions within 60 minutes. All quizzes shall be uploaded under the Assignment folder.

There are two exams (Midterm 1 & Midterm 2) for this course. All exams will be in class or will be uploaded under the Assignments folder (take home exam). All guidelines and materials needed to be covered for each exam or quiz shall be posted on the web.

Make-up exams will be scheduled only in emergencies as per university guidelines.

The **date** for midterm 1 & 2 will be announced at least one week earlier

Grading : Grades will be determined using :

Homework	20%
Quizzes	20%
Midterm 1	30% (date to be announced a week before)
Midterm 2	30% (to be announced later)

Instructor expectation:

- Be regular in class attendance
- Arrive on time
- Be attentive and participate in classroom discussions
- Come prepared to lectures
- Be up to date on previously cover material
- Allocate sufficient time every week to study for this course
- Be prepared to work hard and learn

Pet Peeves:

- Being distracted or distracting others in class
- Not willing to work hard or put an honest effort into learning
- Coming to me late in the semester for grade changes, extra credit, etc.
- Arguing over partial credit on homework/test grades
- Doing other tasks during lectures (including sleeping)
- Cellular phones ringing during lectures

DISABILITY SUPPORT SERVICES (DSS) STATEMENT (must be the following language)

If you have a physical, psychological, medical or learning disability that may impact your course work, please contact Disability Support Services, ECC (Educational Communications Center) Building, room128, [\(631\) 632-6748](tel:6316326748). They will determine with

you what accommodations, if any, are necessary and appropriate. All information and documentation are confidential.

Students who require assistance during emergency evacuation are encouraged to discuss their needs with their professors and Disability Support Services. For procedures and information go to the following website: <http://www.stonybrook.edu/ehs/fire/disabilities>

ACADEMIC INTEGRITY STATEMENT (must be the following language as approved by the undergrad council):

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 are 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/uaa/academicjudiciary/>

CRITICAL INCIDENT MANAGEMENT (must be the following language as approved by the undergrad council):

Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Judicial Affairs any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures.

Students are expected to attend every class, report for examinations and submit major graded coursework as scheduled. If a student is unable to attend lecture(s), report for any exams or complete major graded coursework as scheduled due to extenuating circumstances, the student must contact the instructor as soon as possible. Students may be requested to provide documentation to support their absence and/or may be referred to the Student Support Team for assistance. Students will be provided reasonable accommodations for missed exams, assignments or projects due to significant illness, tragedy or other personal emergencies. In the instance of missed lectures or labs, the student is responsible for review posted PowerPoint slides under the Documents folder and the recorded lecture videos under the Lecture Videos folder. Please note, all students must follow Stony Brook, local, state and Centers for Disease Control and Prevention (CDC) guidelines to reduce the risk of transmission of COVID. For questions or more information click [here](#).