MANE 2720 Fluid Mechanics
Section 2

Dr. Ozgur Tumuklu

Fall 2023

1 Course Information

Course Title .... Fluid Mechanics
Course Number .... MANE 2720
Credit Hours 3
Semester/ Year .... Fall 2023
Meeting Days .... Monday + Thursday: 16:00 - 17:20 pm

Room Location .... Ricketts Building, Room 211

Course Website .... https://lms.rpi.edu
Announcements, supplementary course materials, and discussion will be posted on this website.
Prerequisites .... ENGR 1100 Introduction to Engineering Analysis and PHYS 1100 Physics I.
Corequisite .... MATH 2400 Introduction to Differential Equations.
Advanced Standing .... Engineering.

Instructor .... Prof. Ozgur Tumuklu

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Web: https://mane.rpi.edu/people/faculty/ozgur-tumuklu

Office Hours:[1]
Monday: 11:00 am - 12:00 am
Friday: 4:00 pm - 5:00 pm
By Appointment

Teaching Assistant .... Hannah Arnow

Office: JEC 2203
Email: arbiwh@rpi.edu

Office Hours:
Tuesday: 3:00 pm - 5:00 pm

[1]Office hours are subject to change. Changes will be announced in class and LMS.

By Appointment

Teaching Assistant .... Ullhas Hebbar

Office: JEC 2203
Email: udayau@rpi.edu

Office Hours:
Wednesday: 11:00 am - 1:00 pm

Textbook .... *Fox & McDonald's Introduction to Fluid Mechanics*
Philip J. Pritchard and John W. Mitchell
10th. ed.,[2] ISBN: 978-1-119-60376-4

Supplementary Book .... *Viscous Fluid Flow*
F. M. White
3rd. ed., McGraw-Hill Higher Education, 2006

Supplementary Book .... *Fluid Mechanics Fundamentals and Applications*
Yunus A. Cengel and John M. Cimbala
3rd. ed., McGraw-Hill Higher Education, 2014

Important Dates .... Aug. 28: First day of class
Nov. 22: Thanksgiving recess
Dec. 8: Last day of class
Dec. 14-20: Final Exams
Additional Registrar Dates and Deadlines (linked)

Instructor/course feedback and evaluations will be utilized throughout the semester.

2 Course Outline

Course Description

Explore the fundamental aspects of fluid mechanics, encompassing fluid properties, statics, dynamics of both incompressible viscous and inviscid flows, control volume formulations of continuity, momentum, and energy equations, dimensional analysis, viscous flow in pipes, boundary layers, drag, momentum integral theory, and the realm of turbomachinery.

Course Objectives

The course will focus on the following information:

1. Describe the fundamental concepts and definitions of fluid mechanics, including continuum mechanics, velocity and stress fields, viscosity, and characteristics of Newtonian and non-Newtonian fluids.

2. Comprehend surface tension and capillary effects.

3. Demonstrate the representation of flows using timelines, pathlines, streamlines, and streaklines, and differentiate between these concepts.

[2] 10th edition is preferable but older editions will also be suitable. Digital versions are permitted.

4. Categorize flows as inviscid/viscous, laminar/turbulent, internal/external, and incompressible/compressible.
5. Apply the basic equations of fluid statics.
6. Utilize Archimedes' principle of buoyancy and Pascal's law.
7. Explain the relationship between gauge and absolute pressures, and describe pressure measurement using manometers and barometers.
8. Analyze hydrostatic forces on submerged surfaces.
9. Discuss the Reynolds Transport Theorem, which relates system formations to control volume formations.
10. Analyze continuity and momentum equations in both integral and differential forms.
11. Apply the equations of continuity and momentum to solve practical flow problems.
12. Calculate total, local, and convective accelerations of fluid particles based on the velocity field.
13. Determine the stream function for two-dimensional incompressible flow.
14. Illustrate translation, rotation, and linear/angular deformation of fluid particles.
15. Apply Euler's equations to describe incompressible inviscid flow.
16. Utilize the Bernoulli equation for incompressible inviscid flow.
17. Define static, stagnation, and dynamic pressures, and explain their measurements.
18. Apply dimensional analysis to analyze steady incompressible flow.
19. Define significant dimensionless numbers—Reynolds number (Re), Euler number (Eu), Froude number (Fr), and Mach number (M)—and elaborate on their physical significance.
20. Analyze laminar flow in pipes and between parallel plates, and derive analytical velocity distributions.
21. Calculate flow rates, wall shear stress, and their distribution.
22. Analyze turbulent flow in pipes and ducts using semi-empirical theories and experimental data.
23. Evaluate and compute head losses in pipes and ducts.
24. Discuss the concept of the boundary layer and its thickness.
25. Compare different definitions of boundary-layer thickness: displacement thickness, disturbance thickness, and momentum thickness.
26. Calculate boundary-layer thickness using the momentum integral equation and analyze the effects of pressure gradients on boundary-layer flow.
27. Understand lift, drag, and thrust concepts for airfoils.
28. Introduce the concept of fluid machinery.
29. Conduct analysis of turbomachinery.
30. Examine the general characteristics of pumps, fans, and blowers.

Student Learning Outcomes

At the conclusion of the course, the student should:

1. Exhibit a conceptual grasp of fundamental principles and terminology in fluid mechanics, including concepts like the continuum assumption, velocity and stress fields, viscosity, and differentiation between Newtonian and non-Newtonian fluids.
2. Differentiate among timelines, pathlines, streamlines, and streaklines within a fluid flow scenario.
3. Categorize flow fields based on attributes such as inviscid or viscous behavior, laminar or turbulent flow, internal or external flows, and incompressible or compressible characteristics.
4. Apply the foundational equations of fluid mechanics to diverse static fluid scenarios.
5. Employ integral forms of continuity and momentum equations from fluid mechanics to open flow scenarios using control volume analysis.
6. Utilize the differential forms of the fundamental equations to describe fluid flow in open flow situations.
7. Utilize Bernoulli's and Euler's equations for incompressible inviscid flow fields.
8. Employ non-dimensionalization techniques to define essential dimensionless numbers like the Reynolds number and Froude number.
9. Analyze laminar flow in confined spaces such as between parallel plates and in pipes to derive closed-form analytical expressions.
10. Use the momentum integral equation to compute boundary-layer thickness/profiles for simple laminar flow fields.
11. Understand the fundamental concepts for turbomachinery.

For RPI policy for Institutional Research and Assessment can be found in this link.

Outline

Chapter 1:	Introduction
Chapter 2:	Fundamental Concepts
Chapter 3:	Fluid Statics
Chapter 4:	Basic Equations in Integral Form for a Control Volume
Chapter 5:	Introduction to Differential Analysis of Fluid Motion
Chapter 6:	Incompressible Inviscid Flow
Chapter 7:	Dimensional Analysis and Similitude
Chapter 8:	Internal Compressible Viscous Flow
Chapter 9:	External Incompressible Flow
Chapter 10:	Fluid Machinery

3 Course Calendar

The following table shows a tentative plan for the course. It may be subject to slight changes during the semester. Please refer to the course objectives to find the corresponding **learning outcomes**. Chapter numbers have been assigned for reading assignments accordingly.

Week #	Learning Outcomes	Reading Assignments from Course Book	Homework Assignment
1	1-4	Chapters 1.1-1.6 and 2.1-2.7	1
2	5-8	Chapter 3.1-3.7	2
3-4	9-12	Chapter 4.1-4.9	3
5-6	13-15	Chapter 5.1-5.5	4
Midterm Exam 1 : September 28, 2023 on Chapters 1-3.			
7	16-17	Chapter 6.1-6.3	-
8-9	18-20	Chapter 6.6-6.7 7.1-7.5	6
10	21-22	Chapter 8.1-8.5	7
11	23-24	Chapter 8.6-8.8	8
Midterm Exam 2 : November 02, 2023 on Chapters 4-8.			
12-13	25-27	Chapter 9.1-9.7	9
14	28-30	Chapter 10.1-10.4	10
Final Exam : December 20, 2023 at 11:30 AM- 2:30 PM. Location: TBA on Chapters 1-10.			

4 Grading Policy

Homework (Eight evenly weighted assignments):	25%
Two midterm exams at 25% each:	50%
Cumulative final exam	25%

Grading will be determined on a straight scale based on the RPI policy given in the link:
F (failure): $<$ 60, **D** (poor): 60-66, **D**$^+$ (poor): 67-69, **C**$^-$ (satisfactory): 70-72, **C** (satisfactory): 73-76, **C**+ (satisfactory): 77-79, **B**$^-$ (good): 80-82, **B** (good): 83-86, **B**$^+$ (good): 87-89, **A**$^-$ (excellent): 90-92, and **A** (excellent): 93-100

The instructor retains the authority to adjust grades positively. Generally, the class average is expected to align with the satisfactory to good range.

Extension or special accommodation requests submitted less than 48 hours before the due date will only be considered in cases of emergencies such as illness or family situations. The final decision on granting special accommodations rests entirely with the instructor based on the specific circumstances.

5 Absence Policy

Details of the excused absence policy can be found on the Student Success website (link). If you know you will have an excused absence in advance (funeral, wedding, Rensselaer-sanctioned event, etc.), inform your instructor as early as possible. In the case of illness, no medical excuse is required for absences of up to one week, but you should contact your instructor as soon as possible. Students are responsible for the missed content, and video recordings of lectures will not be provided. In the case of an excused absence on the day of a scheduled midterm exam, students will be eligible for a makeup exam, which will differ from the regular exam, although the content covered will be the same. The timing of makeup exams will be coordinated between the instructors and all affected students. A written make-up exam will not be offered after the cumulative final exam due to time constraints. As needed, the instructor may modify the grading policy or require an oral make-up exam..

6 Academic Integrity

Student-teacher relationships are built on trust. For example, students must trust that teachers made appropriate decisions about the structure and content of the courses they teach, and teachers must trust that the assignments the students that students turn in are their own. Acts which violate this trust undermine the educational process. The Rensselaer Handbook of Student Rights and Responsibilities defines various forms of Academic Dishonesty and you should make yourself familiar with these. In this class, all assignments that are turned in for grade must represent the student's own work. In cases where help was received, or teamwork was allowed, a notation on the assignment should indicate your collaboration.

Submission of any assignment that is in violation of this policy will result in the penalty of a grade of zero for this assignment. If you have any questions concerning this policy before submitting an assignment, please ask the professor for clarification. If you have any question concerning this policy before submitting an assignment, please ask for clarification.

All students are expected to be familiar with and abide by the policies and procedures, including those on academic integrity, contained in the current version of the Rensselaer Handbook of Student Rights and Responsibilities (link). Any individual assignments you submit in this course should be entirely your own work. Copying homework or projects will not be tolerated. You are encouraged to first do your assignments by yourself and then discuss solutions with others. Cheating or plagiarism will result in punitive measures. Violations of academic integrity may also be reported to the appropriate Dean (Dean of Students for undergraduate students or the Dean of Graduate Education for graduate students, respectively).

7 Disability Services

Rensselaer Polytechnic Institute strives to make all learning experiences as accessible as possible. If you anticipate or experience academic barriers based on a disability, please let me know immediately so that we can discuss your options. To establish reasonable accommodations, please register with The Office of Disability Services for Students. After registration, make arrangements with the Director of Disability Services as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion. DSS contact information: dss@rpi.edu; +1-518-276-8197; 4226 Academy Hall.

8 Support Services

PInfo - contains various resource links for students, academic resources, support services, and safety emergency preparedness.

Academic Assistance	ALAC—Advising and Learning Assistance Center	518.276.6269	webpage link
Student Health and Wellness	Counseling Center Student Health Center	518.276.6479 518.276.6287	webpage link webpage link
Student Support Services	Class Deans, Undergraduate Dean, Graduate Experience Dean, Student Success Dean, First Year Experience	518.276.8022	webpage link
DOTCIO (IT Services)	Help Desk, Submit a ticket to IT Services and Support Center	518.276.7777	webpage link