CH.E. 222
FLUID MECHANICS
Fall 2020 - Section 01

Instructor & Assistant	Office	Phone	e-mail
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T 15:40 & 16:40 **F** 10:40 & 11:40

Catalog Description

Hydrostatics. Fundamentals of momentum transport. Newton's law of viscosity. Interphase momentum transport and friction factors. Flow in conduits and around submerged objects. Mechanical energy balances and Bernoulli equation. Dimensional analysis. Applications to practical problems. Principles of settling and filtration.
Prerequisite: MATH 119.

Textbook

P.M. Gerhart, A.L. Gerhart and J.I. Hochsteinch "*Munson's Fluid Mechanics*", Wiley, Global edition.

References

R.B. Bird, W.E. Stewart and E.N. Lightfoot, "*Transport Phenomena*", John Wiley, 2nd edition, 2002.

J.O. Wilkes, "*Fluid Mechanics for Chemical Engineers*", Prentice Hall, 1999.

I. Tosun, "*Modelling in Transport Phenomena"*, Elsevier, 2002.

W.L. McCabe, J.C. Smith and P. Harriott, "*Unit Operations of Chemical Engineering*", McGraw-Hill, 6th edition.

Policies and Procedures

- Lectures will be online.
- A web page has been constructed for this course. All course materials (syllabus, homework assignments, etc.) will be made available at

  http://users.metu.edu.tr/yuludag/che222/

  You need to visit the site on a regular basis to get recent homework assignment and other relevant announcements.
- Attendance is mandatory. Missing more than 8 lecture hours will be considered as NA and loss of the final exam right regardless of other grades. Enrolling in the course during the add-drop session will not be an acceptable excuse.

- You will work in groups of three on the assigned homework sets. E-mail the homework on due date - one solution set per group. Late homework will not be accepted.

- Exams are scheduled as follows:

Midterm Exam # 1	Nov. 20, 2020, Friday
Midterm Exam # 2	Dec. 25, 2020, Friday
Final Exam	TBA

- If you miss an exam with a certified medical excuse, you may take a makeup exam after the final exam. Bear in mind that it will be **CHALLENGING!**

- A weighted average grade will be calculated as follows:

Midterm exams	46 % (23 % each)
Homework	10 %
Term project	8 %
Final exam	36 %

Course Outline

I. Introduction
1. Some Characteristics of Fluids
2. Dimensions, Unit Systems
3. Density, Specific Gravity and Weight
4. Viscosity

II. Fluid Statics
1. Pressure and Basic Equation for Pressure Field
2. Manometry
3. Pressure Variation in a Fluid with Rigid-Body Motion

III. Elementary Fluid Dynamics
1. Newton's Second Law
2. **F** = m **a** Along and Normal to a Streamline
3. Bernoulli Equation, Applications and Restrictions

IV. Differential (Microscopic) Analysis of Fluid Flow
1. Fluid Element Kinematics
2. Conservation of Mass – Continuity Equation
3. Conservation of Linear Momentum - Cauchy Stress Equation
4. Viscous Flow
5. Some Simple Solutions for Viscous, Incompressible Fluids
6. Dimensional Analysis (Scaling) of Navier-Stokes Equations

V. Finite Control Volume (Macroscopic) Analysis
1. Conservation of Mass – Continuity Equation
2. Newton's Second Law - Linear Momentum Equation
3. First Law of Thermodynamics – Energy Equation
4. Second Law of Thermodynamics – Irreversible Flow

VI. Viscous Flow in Pipes
1. General Characteristics of Pipe Flow
2. Fully Developed Laminar Flow
3. Fully Developed Turbulent Flow
4. Dimensional Analysis of Pipe Flow

5. Pipe Flowrate Measurement
6. Loss due to Change in Direction or Cross-Section
7. Effect of Fittings and Valves
8. Practical Use of Velocity Heads in Design

VII. Flow over Immersed Bodies
1. General Characteristics
2. Boundary Layer Characteristics
3. Drag and Lift
4. Terminal Velocity
5. Flow through Packed Beds
6. Fluidization

VIII. Compressible Flow
1. Ideal Gas Relationships
2. Speed of Sound and Mach Number
3. Categories of Compressible Flow
4. Isentropic Flow of an Ideal Gas
5. Nonisentropic Flow of an Ideal Gas

IX. Turbomachines
1. Basic Energy Considerations
2. Centrifugal Pumps
3. Fans and Turbines

Learning Outcomes

AT THE END OF THIS COURSE YOU WILL BE ABLE TO

1. Demonstrate understanding of dimensional consistency.
2. Apply Newton's laws of mechanics to various problems.
3. Apply fluid statics principles to solve for forces and pressure distribution in fluids at static state or rigid-body motion.
4. Distinguish between Newtonian and non-Newtonian fluids and laminar and turbulent flow.
5. Describe the fundamental concepts of momentum transport in laminar and turbulent flow.
6. Analyze simple laminar flow problems at microscopic level.
7. Select and apply appropriate friction factor correlations to compute forces involved in flows through conduits and around submerged objects.
8. Apply macroscopic mass, momentum and energy balances in flow systems.
9. Compute pressure drop/power requirement in piping systems.
10. Identify and select appropriate fluid transportation and measurement devices.
11. Analyze flows involving a compressible fluid.
12. Analyze and design simple pipeline through a group study.