Sabanci University
Faculty of Engineering and Natural Sciences

ME307 Fluid Dynamics

Fall 2022

SCOPE

Course is a standard presentation of the subject at undergraduate level to study motion of fluids and their interaction with solids. The scope includes salient properties of fluids such as viscosity, compressibility and surface tension; important concepts related to fluid flows such as shear and no-slip; basic physical models to calculate pressure in hydrostatic fluids and inviscid flows, flow rate and pressure drop in viscous pipe flows, drag and lift forces on solid objects ; application of conservation laws on control volumes, basic similitude analysis, turbomachinery such as pumps and turbines and open-channel flows.

OBJECTIVES

The course aims to teach basic mathematical models based on conservation laws of fluids and the use of such models in engineering problems that are dealt with in hydrostatics, pipe flows, flow over objects, turbomachinery and alike.

LEARNING OUTCOMES

Upon successful completion of the course, students will be able to understand fundamental aspects of fluid mechanics and mechanisms of fluidic devices such as pumps, compressors, flow meters, and pressure measurement devices, and solve certain problems in fluid statics, internal and external flows.

TEACHING METHODS

Online synchronous lectures focus on the delivery of fundamental material and provide an environment to discuss the salient concepts of fluid mechanics with the help of partially prepared slides and note taking on-slides. There will be limited exercises in lectures, or in-depth examples. Whereas recitation hours will be dedicated to problem solving. Understanding of concepts is extremely important for students to be able to solve the problems on their own. Reading the textbook and going over the examples to reach a level of understanding for problem solving on their own are strongly suggested for students. Homework will be selected exercises from various textbooks on the subject and their variants.

TEXTBOOK & RECOMMENDED READINGS

The following standard textbooks will be used throughout the course. Students must read and complete the examples in the text to learn the material presented in the course.

[MYO] *Fundamentals of Fluid Mechanics*, BR Munson, DF Young, TH Okiishi, Wiley, 7e
[W] *Fluid Mechanics*, F.M. White, McGraw-Hill, 8e

There are several texts on the subject some of which are available in the library.

GRADING

Quizzes: 10%. Quizzes will be held at on SUCourse for attendance at least once a week or more.

In-class midterm(s) exams: 25 % each. Students must have webcams and make sure turn them towards their desk. Make-up oral exams will be held if necessary.

Final exam: 30 %

Take-home quizzes (aka homework): 10 %

Attendance is required, attending less than 70% of the lectures is a letter grade down, less than 50% is an F or NA. Actual attendance rolls and quiz responses will be used as "attendance."

ACADEMIC HONESTY

Cheating, plagiarism and collusion in all aspects of grading (midterm and final exams, take-home quizzes and quizzes) are serious offenses and will be subject to disciplinary action. In particular, but not limited to, **copying** solutions from a classmate or from any source available in written form.

SUGGESTED PREPARATION

Both textbooks are the most common textbooks used in all colleges & university all over the world. You must read them and go over the examples carefully! Try to form study groups of 2-3 people. Discuss how the homework problems and other problems at the end of each chapter can be solved. Don't do the homework together. You should be able to solve any of the problems at the end of each chapter. In-class problem solving during lectures will be very limited, don't rely on it. Lectures will have emphasis on the flow phenomena, physics, assumptions, equations that describe the phenomena and very basic examples. Recitation hours will have emphasis on the solution of selected problems only. Homework will complement the recitations. Problems in the exams will have the same difficulty as the homework, and will be based on the concepts taught in lectures.

SCHEDULE

Reading assignments are provided at the end of each subject for guidance in your preparation to lectures and exams. Reading assignments, especially understanding of the examples in suggested sections **are VERY IMPORTANT.** (I cannot emphasize strongly enough how essential reading and going over the examples are to learn this subject.) MYO is Munson's 7e, and W is White's 8e in the following suggested reading assignments.

Week	Day	Subjects
1	M	Introduction: Syllabus, motivation for fluid mechanics; dimensional homogeneity; shear and no-slip; properties of fluids: viscosity **[read & follow examples from White Ch.1, Munson et al. Ch. 1]**
	T	Properties of fluids: compressibility and surface tension **[Munson 1.9]**
2	M	Fluid Statics: Pressure, hydrostatic equation, pressure distribution in static fluids, pressure measurement **[White Ch. 2]**
	T	Manometry **[Munson 2.6 examples]**
3	M	Hydrostatic forces on planar surfaces **[White 2.5, Munson 2.8]**
	T	Pressure distribution in rigid-body motion **[Munson 2.12 examples]**
4	M	Conservation mass in control volumes **[Munson 5.1, White 3.1-3.3]**
	T	Conservation of linear momentum in control volumes **[White 3.4, Munson 5.2.1-5.2.2]**

5	M	Bernoulli equation in frictionless flows **[Munson 3.1-3.3, White 3.5]**
	T	Examples of Bernoulli **[Munson 3.6]**
6	M	Conservation of angular momentum **[White 3.6, Munson 5.2.3-5.2.4]**
	T	Conservation of energy **[White 3.7, Munson 5.3]**
7	M	Differential analysis of fluid flow: acceleration of fluid, conservation of mass in the differential form (continuity equation), streamlines and streamfunction **[White 4.1-4.2, 4.7; Munson 4.1-4.2, 6.1-6.2]**
	T	Deformation of a fluid element, conservation of linear momentum, vorticity and irrotational flows **[White 4.8, Munson 6.2]**
	R	**Midterm I will be held approximately in the 7 the week during recitation hours on subjects up to end of control volumes.**
8	M	Inviscid irrotational flows, Bernoulli equation (revisit), basic potential flows **[Munson 6.4, 6.5; White 4.9, 8.2]**
	T	Superposition of potential flows, Magnus effect **[White 8.5, 8.7; Munson 6.6]**
9	M	Viscous flow solutions **[Munson 6.8, 6.9; White 4.10]**
	T	
10	M	Dimensional analysis, similarity, dimensionless numbers, Reynolds number **[Munson 7.1-4, White 5.1-4]**
	T	Viscous flows in pipes: fully-developed laminar and turbulent flows, friction factor, major & minor losses in pipe flows**,** pumping power **[Munson 8.1-3; White 6.1-9]**
11	M	
	T	
12	M	Flow over immersed bodies: boundary layers, drag and lift forces **[White7.1-4, Munson 9.1-9.4]**
	T	
13	M	Design of turbomachinery, conservation of angular momentum (revisit), centrifugal pumps **[White 11.1-11.2, Munson 12.1-12.4]**
	T	Axial and mixed flow pumps, fans and turbines **[White 11.4, Munson 12.6]**
	R	**Midterm II will be held approximately in the 13 the week during recitation hours on subjects up to end of Lift & Drag Forces.**
14	M	Compressible flows: Thermodynamics relationships of gasses, adiabatic and isentropic flows **[White 9.1-9.3, Munson 11.1-11.4]**
	T	