ES 15

Mechanics of Fluids

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2nd Semester of A.Y. 2016–2017.
THV2: ME 4 TTh 11:30–13:00.

COURSE OBJECTIVES

This course tackles the fundamental concepts, statics, kinematics, and dynamics of fluids in engineering context. It requires a *strong* grasp of core undergraduate-level mathematical and physical principles, i.e. vector calculus and classical mechanics. This course aims to:

- Introduce students to the beautiful world of fluid mechanics and its engineering applications.
- Provide students with the ability to model and analyze fluid flow phenomena in engineering systems.
- Enhance students' analytical and problem-solving skills via a reasonable number of guided and unguided problem-solving exercises.

LEARNING OUTCOMES

After successful completion of the course, students should be able to:

- Define and explain fundamental concepts in fluid mechanics.
- Identify, classify, and describe fluid flow phenomena encountered in engineering systems.
- Apply core mathematical and physical principles in modeling and analyzing fluid flow phenomena.
- Mathematically model fluid flow phenomena and apply appropriate simplifying assumptions.
- Analyze mathematical models and experimental data of fluid flow phenomena.
- Systematically solve engineering problems involving fluid mechanics.
- Explain the importance of fluid mechanics in mechanical, naval, and aeronautical engineering.

REFERENCES

- Munson, B. R., Young, D. F., Okiishi, T. H., & Huebsch, W. W. (2009). *Fundamentals of Fluid Mechanics* (6th ed.). Hoboken, NJ: Wiley. *
- White, F.M. (2011). *Fluid Mechanics* (7th ed.). New York, NY: McGraw-Hill.
- Anderson, J.D. (2011). *Fundamentals of Aerodynamics* (5th ed.). New York, NY: McGraw-Hill.
- Granger, R.A. (1995). *Fluid Mechanics*. New York, NY: Dover. (Original work published 1985)
- Cleynen, O. (2016). *Fluid Mechanics for Masters Students* [PDF document]. Retrieved from http://fluidmech.ariadacapo.net

CALENDAR

Lecture	Topics	Activities
0	Course introduction	
Fundamental Concepts and Fluid Statics		
1	Fluid characteristics and behavior	R1: 1.0–1.11
	Thermodynamic and transport properties of fluids	
2	The concept of pressure and its measurement	R2: 2.0–2.7
3	Hydrostatics	A1; R3: 2.8–2.10
4	Buoyancy and stability	R4: 2.11–2.13
	Fluids under rigid-body motions	
The Most Elementary Model of Fluid Dynamics		
5	The Bernoulli equation (BE)	A2; R5: 3.0–3.4
6	The concept of stagnation	R6: 3.5–3.6
	BE applications	
7	Graphical interpretation of BE	A3; R7: 3.7–3.9
	Restrictions of BE	
Fundamentals of Modeling and Analysis in Fluid Dynamics		
8	Velocity and acceleration fields	R8: 4.0–4.2
9	The Reynolds transport theorem	A4; R9: 4.3–4.5
10	Fluid dynamics in integral form I: mass and momentum	R10: 5.0–5.2
11	Fluid dynamics in integral form II: energy and irreversibility	A5; R11: 5.3–5.5
12	Fluid dynamics in differential form	R12: 6.0–6.3
13	Inviscid flows and potential flows	A6; R13: 6.4–6.7
14	Viscous flow and other aspects of fluid dynamics	R14: 6.8–6.11
	End of midterm exam coverage	
The Role of Experiments in Fluid Mechanics		
15	Dimensional analysis	A7; R15: 7.0–7.4
16	Dimensionless groups	R16: 7.5–7.7
	Correlation of experimental data	
17	Modeling and similitude	A8; R17: 7.8–7.11
Viscous Flow		
18	Internal flow I: characteristics and fully developed flow	R18: 8.0–8.3
19	Internal flow II: dimensional analysis	A9; R19: 8.4
20	Internal flow III: examples and measurement methods	R20: 8.5–8.7
21	External flow I: characteristics and boundary layers	A10; R21: 9.0–9.2
22	External flow II: drag and lift	R22: 9.3–9.5
23	Open-channel flow I: characteristics, waves, and energy	A11; R23: 10.0–10.3
24	Open-channel flow II: classifications	R24: 10.4–10.7
Compressible Flow		
25	Fundamental aspects of compressible flow	A12; R25: 11.0–11.3
26	Isentropic compressible flow	R26: 11.4
27	Nonisentropic compressible flow	A13; R27: 11.5
28	Further understanding of compressible flow	R28: 11.6–11.8
	End of final exam coverage	
Fluid Mechanics and Beyond		
29	Other applications of fluid mechanics I: aeronautical engineering	A14
	Other applications of fluid mechanics II: naval engineering	

REQUIREMENTS

- *Readings*. 28 instances at 0% each. Students should read assigned readings before corresponding lectures.
- *Assignments*. 14 instances at 2% each. Collaboration is highly encouraged and allowed but copying is not. All should be submitted in due time; failure to do so will result to a grade of 5.0.
- *Exams*. The midterm exam is 32% and the final exam is 40%. Scores are out of 100 and should not go below 30.