Course-Plan

School: Engineering
Department: Mechanical Engineering
Course Code: ME:209
Course Name: Fluid Mechanics-II

Instructor: Dr. Prabin Haloi

1. Abstract

The subject Fluid Mechanics-II is closely associated to thermal engineering. At the undergraduate level, the knowledge and understanding of fluid mechanics is primarily essential for mechanical, aerospace, geophysics, automobile, chemical, and biomedical engineering students. The course covers the fundamental concepts of boundary layer, description of turbulent and compressible flows, and the various turbo-machineries. The governing equations of boundary layer flows, relations associated with compressible flows and the working principles of the fluid machineries are discussed. It also involves analysis of laminar and turbulent boundary layer problems, problems associated with compressible flows, and analyses of hydraulic turbines and pumps. Therefore, the course Fluid Mechanics-II is an extension of the basic Fluid Mechanics-I. Therefore, a good knowledge of both the parts of Fluid Mechanics will be beneficial to the students of engineering. From this course, the students will gain a thorough knowledge and understanding of the subject that will help in the design and solution of fluid mechanics related equipments and problems.

2. Objectives

The course will have the following objectives-

1. To introduce the fundamental concept of boundary layer, boundary layer thickness, separation of boundary layer and governing equations.

2. To orient students to gain clear concept and solution of mathematical problems of boundary layers.

3. To introduce students to turbulent flows and its governing equations and problems of turbulent flow.

4. To introduce students to compressible flows, relations and problems of compressible flows.

5. To make students identify and understand the different types of hydraulic turbines and pumps, their working principles and performances.

6. To orient students towards research works related to fluid mechanics problems.

3. Prerequisites of the course

Knowledge of Fluid Mechanics-I (ME 202) is essential for this course.

4. Course Outline:

- Introduction to boundary layers
- Turbulent Flow
- Compressible Flow
- Turbo machinery

5. Time Plan

Topic	Contents	Contact Hours			
		L	T	P	C
Introduction to Boundary Layer Concepts	Boundary layer flow, definition of boundary layer, velocity boundary layer, boundary layer flow over a flat plate, laminar and turbulent boundary layer over a flat plate, concept of critical Reynolds number, boundary layer thickness	1	0	0	1
	Displacement, momentum and energy thickness of boundary layer, boundary layer equations	1	1	0	2
	Similarity solution, Von Karman momentum integral equation, boundary layer separation, flow past immersed bodies	2	1	0	3
Turbulent Flow	Transition from laminar to turbulent flows, governing equations of turbulent flow and its derivation	2	0	0	2
	Turbulent boundary equations, Prandtl mixing length hypothesis	1	1	0	2
	Universal velocity distribution law, friction factor and its correlation	1	1	0	2
Compressible flows	Introduction to compressible flows, speed of sound, adiabatic and isentropic steady flows, Mach-number relations	2	1	0	3
	Isentropic flows with area changes, nozzle and diffuser	2	1	0	3
	Shock waves, Normal-shock wave, Rankine-Hugoniot relations	3	1	0	4
	Fanno and Rayleigh flows, performance of nozzles	2	1	0	3
Turbo Machinery	Euler equation for turbo machines, hydraulic turbines: impulse and reaction turbines, Pelton wheel, Francis turbine, Kaplan/propeller turbine	4	2	0	6
	Water hammer, surge tank, pumps: rotodynamic and positive displacement pumps, working principles of reciprocating pumps, air vessels, centrifugal pumps,	3	1	0	4
	Performance characteristics of centrifugal pump, non-dimensional terms, specific speed, cavitation, net positive suction head (NPSH)	3	2	0	5

Text Books:

1. White, F. M. Fluid Mechanics. McGraw-Hill Education, 8th edition, 2015.
2. Anderson Jr., J. D. Modern Compressible Flow with Historical Perspective. McGraw-Hill Education (India) Pvt. Ltd., 3rd edition, 2017.

Reference Books:

1. Chakrabarty, S., Som, S. K. and Biswas G. Introduction to Fluid mechanics and Fluid Machines. Tata McGraw Hill, 3rd edition, 2012.
2. Zucker, R. D. and Biblarz, O. Fundamentals of Gas Dynamics. John Wiley and Sons, 2nd edition, 2002.

6. Pedagogy:

In this course, the teaching-learning methods to be used are as follows:

- Lecture and discussion/questioning
- Class test, quizzes
- Mid and end semester test
- Laboratory visit/field work
- Presentation/seminar /Assignments

7. Expected Course Outcomes (COs):

Towards the end of the course the students will be:

- Solve laminar and turbulent pipe-flow problems.
- Analyze and solve laminar and turbulent boundary-layer problems.
- Solve compressible-flow problems involving isentropic flows, flows with normal shocks, flow through a converging-diverging nozzle with shocks, compressible flow problems involving friction and heat transfer
- Carry out analysis of Pelton, Francis and Kaplan turbines, reciprocating and centrifugal pumps.
- Extend the knowledge of dimensional analysis and similitude to the analysis of turbo machines.