Fluid Mechanics II

Academic Year: (2019 / 2020) **Review date: 19/05/2020 11:33:35**

Department assigned to the subject: Thermal and Fluids Engineering Department

Coordinating teacher: RODRIGUEZ RODRIGUEZ, FRANCISCO JAVIER

Type: Electives ECTS Credits : 6.0

Year : 2 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Calculus I & II, Linear Algebra, Physics I & II, Fluid Mechanics I

OBJECTIVES

Fundamental and applied knowledge of the laws that determine the fluid motion, with emphasis on high-Reynolds-numbers flows and gases, and their application to the description of problems of interest in aerospace engineering.

DESCRIPTION OF CONTENTS: PROGRAMME

Introduction to ideal flow: The Navier-Stokes equations. External aerodynamic flow: the Reynolds number and the Mach number. Euler equations. Isentropic flow. Quasi-steady motion: the Strouhal number. Euler-Bernoulli equation. Total (stagnation) thermodynamic properties.

Applications of ideal flow: Ideal flows in pipes. Incompressible motion. Steady gas flow in pipes. Subsonic and supersonic flow. Convergent nozzels. Analysis of ideal fluid machines. Pumps, compressors, and turbines.

Irrotational flow: Irrotational motion. Plane potential flow. The complex potential. Superposition of elementary solutions. Flow over a cylinder. Conformal mapping. Joukowski transformation. Exercises.

Boundary-layer flow: Boundary-layer concept. Introduction. Scales. Equations and boundary conditions. Boundary-layer thickness. Blasius solution. Boundary-layer integral methods. Thermal boundary layer. Boundary-layer separation.

Flows with discontinuities: Tangential and normal discontinuities. Shock waves. Normal shock relations. Oblique shock waves. Prandtl-meyer expansion. Convergent-divergent nozzels.

Turbulent flow: Flow stability. Turbulence characteristics. Reynolds stresses. Turbulent motion near walls. The Moody diagram. Incompressible turbulent flow in pipes. Equations. Gaseous turbulent flow. Simplified solutions for long pipes. Turbulent flow in insulated pipes. Frintionless flow with heat addition.

LEARNING ACTIVITIES AND METHODOLOGY

The methodology will combine lecture classes for presentation of the fundamentals with problem solving sessions. The four laboratory sessions are to take place in the computer room (1) and in the experimental laboratory (3). The problems to be addressed include external aerodynamics and turbulent flow in pipes.

ASSESSMENT SYSTEM

% end-of-term-examination/test:	35
% of continuous assessment (assigments, laboratory, practicals…):	65

Laboratory reports (20%)
Midterm (35%): it will cover from ideal flows to boundary layers, including both subjects. If the grade is greater or equal to 5.0, the student will not have to take this part in the final exam.

% end-of-term-examination/test: 35

% of continuous assessment (assigments, laboratory, practicals…): 65

Homework (10%): it will cover the topic of potential flows.
Final exam (35%): it will cover flows with discontinuities and turbulent flows. A minimum grade of 5.0 is required to pass the course.

BASIC BIBLIOGRAPHY

- G. K. Batchelor An Introduction to Fluid Dynamics, Cambridge University Press, 1967

- L. D. Landau & E. M. Lifshitz Fluid Mechanics, Pergamon Press, 1987

- Liepman HW and Roshko A Elements of gas dynamics, Dover publications, 2002

- P. A. Lagerstrom Laminar Flow Theory, Princeton University Press, 1996