Fluid Mechanics

Academic Year: (2023 / 2024) **Review date: 09-05-2023**

Department assigned to the subject: Thermal and Fluids Engineering Department

Coordinating teacher: SEVILLA SANTIAGO, ALEJANDRO

Type: Electives ECTS Credits : 6.0

Year : 4 Semester :

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Calculus I, II
Physics I, II
Linear Algebra
Thermal Engineering
Engineering Fluid Mechanics

SKILLS AND LEARNING OUTCOMES

CB1. Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study
CB2. Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.
CB3. Students have the ability to gather and interpret relevant data (usually within their field of study) in order to make judgements which include reflection on relevant social, scientific or ethical issues.
CB5. Students will have developed the learning skills necessary to undertake further study with a high degree of autonomy.
CG1. Ability to solve problems with initiative, decision-making, creativity, critical reasoning and to communicate and transmit knowledge, skills and abilities in the field of Industrial Engineering.
CG3. Ability to design a system, component or process in the field of Industrial Technologies to meet the required specifications
CG4. Knowledge and ability to apply current legislation as well as the specifications, regulations and mandatory standards in the field of Industrial Engineering.
CG5. Adequate knowledge of the concept of company, institutional and legal framework of the company. Organisation and management of companies.
CG6. Applied knowledge of company organisation.
CG8. Knowledge and ability to apply quality principles and methods.
CG9. Knowledge and ability to apply computational and experimental tools for the analysis and quantification of Industrial Engineering problems.
RA1. Knowledge and understanding: Have basic knowledge and understanding of science, mathematics and engineering within the industrial field, as well as knowledge and understanding of Mechanics, Solid and Structural Mechanics, Thermal Engineering, Fluid Mechanics, Production Systems, Electronics and Automation, Industrial Organisation and Electrical Engineering.
RA2. Engineering Analysis: To be able to identify engineering problems within the industrial field, recognise specifications, establish different resolution methods and select the most appropriate one for their solution
RA4. Research and Innovation: To be able to use appropriate methods to carry out research and make innovative contributions in the field of Industrial Engineering.

OBJECTIVES

The objective of this course is to provide the student an understanding of fluid mechanics at an intermediate level. After attending this course, the student should be able to apply the mass, momentum and energy conservation laws in their differential form to study problems of relevance in engineering.

Knowledge mastered in this course:

- Understand the relative importance of the different terms in the conservation equations in differential

form,
and develop reduced models based on dominant balances.
- Determine the adequate methodology to obtain the required variables in an engineering problem (analysis, experiment, etc.).
- Present results in a rational manner, in terms of the minimum number of relevant parameters, by making use of dimensional analysis and nondimensionalization of the governing equations.
- Determine similarity solutions in fluid-dynamics problems.
- Comprehension of basic terminology to understand technical documentation and specific literature.

Specific capacities:

- Write the appropriate set of differential equations, as well as their initial and/or boundary conditions, whose integration determines the flow field.
- Write and solve unidireccional flow problems.
- Write and solve problems under conditions of dominant viscous forces.
- Apply hydrodynamic lubrication theory to solve relevant problems in engineering.
- Apply ideal flow theory to solve relevant problems in engineering.
- Apply boundary layer theory to solve relevant problems in engineering.

General capabilities:

- Analysis based on basic scientific principles.
- Multidisciplinar approach (use knowledge from several disciplines: Mechanics, Thermodynamics, Calculus, etc.)
- Capacity to locate and understand basic literature on the subject, needed in the solution of flow problems.

Attitudes:

- Analytical attitude when facing engineering problems.
- Critical attitude given the different choices available to tackle a given problem.
- Cooperative attitude to exchange information and knowledge.

DESCRIPTION OF CONTENTS: PROGRAMME

This is a course in Fluid Mechanics at an intermediate level. The Programme is divided in 7 parts:

FIRST PART: Introduction. Summary of conservation equations in integral and differential form.
SECOND PART: Unidirectional flow of liquids.
THIRD PART: Quasi-unidirectional viscosity-dominated flows of liquids.
FOURTH PART: Hydrodynamic lubrication theory. The Reynolds equation.
FIFTH PART: Introduction to ideal flow theory.
SIXTH PART: Introduction to compressible flows.
SEVENTH PART: Boundary layer theory.

LEARNING ACTIVITIES AND METHODOLOGY

The teaching methodology will incluye:

1. Lectures: The students will be provided with lecture notes and recommended bibliography.
2. Problem solving sessions, related with the course topics.
3. Homework problems aiming at student self-evaluation.
4. Development and interactive presentation of guided works, including four lab session as direct application of theory.

ASSESSMENT SYSTEM

The continuous evaluation will be based on:

- 3 take-home quizzes will be proposed during the semester (40% of continuous evaluation grade).
- 2 presential quizzes will take place during the semester (40% of continuous evaluation grade).
- Laboratory work: 4 computing room sessions. Reports are due after each session (20% of continuous evaluation grade).

It is possible to pass the course without final exam.

For those students who failed in the continuous evaluation:

- Ordinary examination: 60% of the total grade, remaining 40% coming from continuous evaluation.
- Extraordinary examination: 100% of the total grade, or 60%+40% coming from continuous evaluation (the best option for each student).

% end-of-term-examination:	60
% of continuous assessment (assigments, laboratory, practicals…):	40

BASIC BIBLIOGRAPHY

- Antonio Barrero, Miguel Pérez-Saborid Fundamentos y Aplicaciones de la Mecánica de Fluidos, McGraw Hill, 2004
- Antonio Crespo Martínez Mecánica de Fluidos, Thomson, 2006
- Antonio Luis Sánchez Pérez Introduction to Fluid Mechanics, Área de Mecánica de Fluidos, 2011
- José Manuel Gordillo, Guillaume Riboux, Juan Fernández Introducción a la mecánica de fluidos, Paraninfo, 2017

ADDITIONAL BIBLIOGRAPHY

- Amable Liñán Martínez Mecánica de Fluidos (Volúmenes I y II), Publicaciones de la ETS de Ingenieros Aeronáuticos, Universidad Politécnica de Madrid, 2006
- D. J. Acheson Elementary Fluid Dynamics, Clarendon Press, 1990
- G. K. Batchelor An introduction to fluid dynamics, Cambridge University Press, 2000
- J. H. Spurk Fluid Mechanics: Problems and Solutions, Springer Verlag, 1997
- L. D. Landau, E. M. Lifshitz Mecánica de Fluidos, Reverté, 1985

BASIC ELECTRONIC RESOURCES

- National Commitee for Fluid Mechanics Films. A. Shapiro (editor) . Fluid Mechanics Films: http://web.mit.edu/hml/ncfmf.html