Fluid transport and hydraulic machinery

Academic Year: (2023 / 2024) **Review date: 07/06/2023 14:37:01**

Department assigned to the subject: Thermal and Fluids Engineering Department

Coordinating teacher: SEVILLA SANTIAGO, ALEJANDRO

Type: Compulsory ECTS Credits : 6.0

Year : 3 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

- All previous courses on Mathematics (Calculus, Algebra, etc.)
- Engineering Fluid Mechanics

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.
CB4. Students should be able to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.
CB5. Students will have developed the learning skills necessary to undertake further study with a high degree of autonomy.
CG2. Apply computational and experimental tools for analysis and quantification of energy engineering problems
CG4. Being able to do design, analysis, calculation, manufacture, test, verification, diagnosis and maintenance of energetic systems and devices.
CG10. Being able to work in a multi-lingual and multidisciplinary environment
CE17 Módulo CRI. Knowledge of the basic principles of fluid mechanics and their application for solving problems in the field of energy engineering. Pipeline, channel and fluid systems calculation.
CE2 Módulo TE. Applied knowledge on the fundamentals of fluid mechanics systems and machines.
CT1. Ability to communicate knowledge orally as well as in writing to a specialized and non-specialized public.
CT2. Ability to establish good interpersonal communication and to work in multidisciplinary and international teams.
CT3. Ability to organize and plan work, making appropriate decisions based on available information, gathering and interpreting relevant data to make sound judgement within the study area.
CT4. Motivation and ability to commit to lifelong autonomous learning to enable graduates to adapt to any new situation.

By the end of this content area, students will be able to have:
RA1.2 a systematic understanding of the key aspects and concepts of heat transfer.
RA2.1 the ability to apply their knowledge and understanding to identify, formulate and solve advanced problems within the field of thermal engineering and fluid mechanics using established methods.
RA2.3 the ability to select and apply relevant analytic and modelling methods in the field of thermal engineering and fluid mechanics.
RA3.1 the ability to apply their knowledge and understanding to develop and realise designs to meet defined and specified requirements within the field of thermal engineering and fluid mechanics.
RA4.2 the ability to design and conduct appropriate experiments, interpret the data and draw conclusions.

RA5.3 an advanced understanding of applicable techniques and methods within the field of thermal engineering and fluid mechanics, and of their limitations;
RA6.1 function effectively as an individual and as a member of a team.

OBJECTIVES

The objective of this course is to get the student to be able to apply Fluid Mechanics to Industrial problems; essentially to deal with networks to transport and distribute fluids. The student will learn specific techniques and will develop his capcity to deal with this kind of problems.

At the end of this course, the student will be capable of:
- Understand the problematics of fluid transport through networks.
- Use adequate hypothesis to apply the conservation equations to real problems.
- Identify the different elements in a fluid transport network.
- Define the necessary steps to design and analyze a fluid distribution installation.

DESCRIPTION OF CONTENTS: PROGRAMME

This is an eminently practical course, so the student must master the necessary fundamental knowledges at the time on enrollment.

CHAPTER 1: Steady flow of liquids in ducts
1.1 Primary head losses. Colebrook correlation and Moody's chart.
1.2 Non-circular cross-section ducts. Hydraulic diameter.
1.3 Localized head losses: Valves, Elbows, curves, expansions, contractions, etc.
1.4 Coupling of turbomachinery to hydraulic facilities.

CHAPTER 2: Steady flow of liquids in pipe networks.
2.1 Pipes in series and in parallel.
2.2 Analysis of branched ducts: the three-reservoir problem.
2.3 Analysis of closed-loop pipe networks. Matrix algorithm and its numerical implementation.

CHAPTER 3: Unsteady phenomena in pipe flow.
3.1 Theory of unsteady incompressible flow in ducts.
3.2 Characteristic acceleration and discharge times. Quasi-steady flow.
3.3 Order-of-magnitude analysis of characteristic variables in unsteady pipe networks flow. Non-dimensionalization of the equations.
3.4 Applications. Surge tanks.
3.5 Compressibility effects. Basic theory of water hammer. Reflection and transmission of waves. Applications.

CHAPTER 4: Introduction to turbomachinery.
4.1 Definitions. Classification of incompressible fluid machines.
4.2 Characteristic curves of pumps ad turbines.
4.3 Cavitation in turbomachinery.
4.4 Similarity in pumps.
4.5 Similarity in turbines.
4.6 Coupling of pumps and turbines to a hydraulic network.

LEARNING ACTIVITIES AND METHODOLOGY

The methodology will combine:
(1) Lectures for the presentation of the fundamentals.
(2) Problem solving sessions.
(3) Laboratory sessions will consist of an introduction to the design and computation of pipe networks. The students will have to elaborate a project and present a report.

ASSESSMENT SYSTEM

% end-of-term-examination/test:	50
% of continuous assessment (assigments, laboratory, practicals…):	50

The continuous assessment grading is based on two partial exams and one numerical lab.

- The numerical lab consists in implementing a standard method to design and solve a given pipe

% end-of-term-examination/test: 50

% of continuous assessment (assigments, laboratory, practicals…): 50

network. It contributes to 20% of the continuous assessment grade.

- The first partial exam (EP1) covers chapters 1 to 3, and contributes to 40% of the continuous assessment grade. Provided that EP>=5 and TC>=5, this part of the course can be disregarded by the student in the ordinary final exam.

- The second partial exam (EP2) covers chapters 4 and 5, and contributes 40% to the continuous assessment grade. Provided that EP2>=5, this part of the course can be disregarded by the student in the ordinary final exam.

- The continuous assessment grade (EC) is obtained according to EC=0.2*TC+0.4*EP1+0.4*EP2. If EC >=5, provided that EP1>=4 and EP2>=4, the student does not need to do the Final exam.

- The ordinary final exam is divided into two parts, corresponding to chapters 1 to 3 (EFO1) and to chapters 4 and 5 (EFO2). The grade of this exam is calculated with the equation EFO=0.5*MAX(EP1,EFO1)+0.5*MAX(EP2,EFO2), in order to pass it is required that EFO1>=4 and EFO2>=4, except in the case that the course has already been passed in the continuous assessment.

- The extraordinary final exam (EE) contemplates all the topics of the course.

The final grade of the course (NF) is given by the following formulae:

ORDINARY:
NF=0.2*TC+0.15*EP1+0.15*EP2+0.5*EFO

EXTRAORDINARY:
NF=MAX(0.2*TC+0.8*EFE,EFE)

The course is passed if NF >= 5.

During the examinations the student is not allowed to use any material in addition to that provided by the teacher, with the exception of a scientific calculator.

BASIC BIBLIOGRAPHY

- A. Crespo, J. Hernández Problemas de Mecánica de Fluidos y Máquinas Hidráulicas, Cuadernos de la UNED, 1996

- Crespo Martínez, Antonio. Mecánica de fluidos. , Thomson Paraninfo. , 2006

- George F. Round Incompressible Flow Turbomachines: Design, Selection, Applications, and Theory, Butterworth-Heinemann, 2004

- M Hanif Chaudhry Applied Hydraulic Transients, Springer, 2014

- M. Vera, I. Iglesias, A. Sánchez, C. Martínez Ingeniería Fuidomecánica, Paraninfo, 2012

- Ven Te Chow Open-Channel Hydraulics, The Blackburn Press, 1999.

- White, Frank Fluid Mechanics, McGraw-Hill , 2010