Fluid transport and hydraulic machinery

Academic Year: (2019 / 2020) **Review date: 04-04-2019**

Department assigned to the subject: Thermal and Fluids Engineering Department

Coordinating teacher: FERNANDEZ TARRAZO, EDUARDO ANTONIO

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

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-reservoirs 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 pipenetworks 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 lecture classes for presentation of the fundamentals with problem solving sessions. The laboratory sessions, to take place in the computer room, will consist of an introduction on matlab to enable the students to use advanced mathematical techniques to solve the hydraulics equations for distribution networks. The students will have to elaborate a project and present a report.

ASSESSMENT SYSTEM

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

- The numerical lab consists in developing a numerical code to solve a given pipe network. It contributes to 20% of the continuous assesment grade. To pass the course it is required that TC>=5.

- The first partial exam (EP1) covers chapters 1 to 3, and contributes to 40% of the continuous assesment 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 assesment grade. Provided that EP2>=5, this part of the course can be disregarded by the student in the ordinary final exam.

- The continuous assesment 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 assesment.

- 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.

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

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