Universitat de Lleida

DEGREE CURRICULUM

FLUIDS ENGINEERING

Coordination: ILLA ALIBES, JOSEP

Academic year 2023-24

FLUIDS ENGINEERING 2023-24

Subject's general information

Subject name	FLUIDS ENGINEERING
Code	102302
Semester	2nd Q(SEMESTER) CONTINUED EVALUATION
Typology	Degree / Course / Character / Modality: Bachelor's Degree in Energy and Sustainability Engineering / 3 / COMPULSORY / Attendance-based Bachelor's Degree in Mechanical Engineering / 3 / COMPULSORY / Attendance-based Double bachelor's degree: Degree in Mechanical Engineering and Degree in Energy and Sustainability Engineering / 3 / COMPULSORY / Attendance-based
Course number of credits (ECTS)	6
Type of activity, credits, and groups	Activity type: PRAULA / TEORIA Number of credits: 3 / 3 Number of groups: 3 / 1
Coordination	ILLA ALIBES, JOSEP
Department	INDUSTRIAL AND BUILDING ENGINEERING
Teaching load distribution between lectures and independent student work	Attendance time: 60 h. Home work: 90 h.
Important information on data processing	Consult this link for more information.
Language	Catalan
Distribution of credits	Theory: 3 cr. Problems: 2 cr Case study: 1 cr

Typology:

Degree	Course	Character	Modality
Bachelor's Degree in Energy and Sustainability Engineering	3	COMPULSORY	Attendance-based
Bachelor's Degree in Mechanical Engineering	3	COMPULSORY	Attendance-based
Double bachelor's degree: Degree in Mechanical Engineering and Degree in Energy and Sustainability Engineering	3	COMPULSORY	Attendance-based

Type of activity, credits, and groups:

Activity type	PRAULA	TEORIA
Number of credits	3	3
Number of groups	3	1

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Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
ILLA ALIBES, JOSEP	josep.illa@udl.cat	12	

Subject's extra information

Suggestions

The present course is based on the concepts already exposed in Mechanics of Fluids and is intended to achieve the level of analysis commonly used in the practice of engineering design. The difficulty in the analysis of complex fluid systems forces the use of numerical computational techniques where the major handicap is the accurate design of the algorithms adapted to each problem type. It is recommended for the student to refresh the concepts of Fluid Mechanics, Numerical Methods and Programming given in previous courses.

The course as part of the academic plan

The fluids system engineering is a part of mechanics, considered as a whole discipline. With that background the present course provides a practical perspective integrating concepts both from Mechanics and Fluid Mechanics. The course will take place during the second semester and is structured in 3cr theory, 2cr problems and 1cr practicum. In the individualized practicum specific problems will be proposed and the student will have to develop a strategy to solve each of them and implement it in Matlab. Some basic references for the course are in english.

Learning objectives

-Establish the equations that define the steady state in elemental pumping facilities.

-Apply basic numerical algorisms to solve problems of facilities with pumps.

-To set out and run algorisms to optimize the design and operation of basic facilities.

-To set out and solve numerically the equations defining the steady state in hydraulic networks using different approaches.

-Develop numerical algorisms for the analysis of hydraulic networks.

-To set out the equations governing hydraulic transients and development of the algorisms to find out approximate numerical solutions.

Competences

Degree-specific competences

- GEM21. Applied knowledge of thermal engineering.
- GEM24. Applied knowledge of the basics of fluid mechanic machinery.

Degree-transversal competences

- EPS1. Capacity to solve problems and prepare and defence arguments inside the area of studies.
- EPS6. Capacity of analysis and synthesis.

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Subject contents

Chapter 1. INTRODUCTION TO MATLAB

1. Types of variables in Matlab

2. Logical and arithmetic operators

3. Mathematical functions

4. Loops and conditionals

5. Main programs and user defined functions

6. Basic numerical algorithms:

    -Bisection and secant methods

    -The Newton-Raphson method for non linear equation systems

    -Ordinary differential equations: The Euler method

    -Fitting curves with the least squares criterion

7. Examples of elemental numerical algorisms in Matlab

Chapter 2. BASIC HYDRAULIC SYSTEMS

1. Series pipe configuration

2. Parallel pipe configuration

3. The three reservoir problem

4. Working point

5. Cavitation in pumps. The concept of NPSH

6. Numerical fitting of the characteristic pump curve

7. Similitude laws in centrifugal pumps

8. Global fitting of a family of characteristic curves according the similitude laws

9. Optimal diameter

10. Optimal working point of a facility

11. Non newtonian fluids

12. Problems of elemental hydraulic systems

Chapter 3. INTRODUCTION TO PIPE NETWORK ANALYSIS

1. General concepts. Basic types of networks

2. Equations governing the flow of an hydraulic network

3. Exponential formula for the continous head loses in a pipe

4. Relation between the exponential law and the Darcy-Weisbah equation

5. The Q-equations method

6. Method of Hardy-Cross method

7. The H-equations method

8. Sistematization of the H-equations method

9. Introduction of pumps in the network

10. Problems of pipe network analysis

Chapter 4. INTRODUCTION TO TRANSIENT FLOW

1. The Euler equation on a streamline

2. Relation between wall stress and the Darcy-Weissbach friction factor

3. Transients without inertia and elasticity

4. Transients with inertia (rigid column flow)

5. Transients with inertia and elasticity. Basic description of the water hammer.

6. Equations governing the water hammer

7. Numerical solutions. The characteristics method

6. Transients in networks

7. Problems of transients

Methodology

Master class, where the basic concepts are exposed in a deductive sequence.

Problem solving. The methodology to solve the typical problems is exposed, starting from the basic concepts.

Case study. The different approaches to analyze a complex problem, the adopted solution strategies and the form to present the achieved results are discussed. The students should present their own work within an established death line and defend it orally.

Written exam. At day and time established by the study board. Each student has to solve by its own the proposed questions in a limited time. The students know the punctuation criteria.

Development plan

Week	Methodology	Contents	Attendance hours	Autonomous working hours
1-2	Master class Problems	Chapter 1	8	12

3-8	Master class Problems Case study	Chapter 2 Chapter 3 (up to 3.6)	24	36
9	Written exam (E1)	Chapter 1 up to Chapter 3.6	3	
10-15	Master class Problems Case study	Finishing Chapter 3 Chapter 4	24	36
16	Written exam (E2)	Chapters 1 to 4	3	

Evaluation

There will be a written exam by mid semester (E1) and by the end of the semester (E2) and a final recuperation exam (EJ) on the dates established by the Direction of the EPS. During the course there will be at least 4 practical cases (P) proposed due to be solved and presented at a established date . Solving those cases is optional, but its content is subject of the exams and every student may be asked to do a oral presentation and defense of each case. The mark of the course (NJ) will be formed based on the three blocs: exam E1, exam E2 and practical cases, according the following criteria:

Criterion A. For a person who has not presented all of the practical cases between the established deathline:

NJa=max{(E1+E2)/2,E2}.

Criterion B. For a person who has presented all the proposed practical cases between the established deathline:

NJb=NJa if NJa<3

NJb=0.7*NJa + 0.3*P if NJa>=3

Those who did not pass with criterion A or criterion B will have a second opportunity with the final recuperation exam (EJ), which mark will replace the mark NJa.

The professor can round the decimal values of a mark to a multiple of 0.5 either increassing or decresing it.

The students under ‘alternative evaluation’ system will have the mark obtained from exam E2, and if a second attempt is needed, they can do it taking the final exam EJ.

Bibliography

Basic references:

-J.Agüera Soriano, “Mecánica de fluidos incompresibles y turbomáquinas hidráulicas”, 5ª ed., Editorial Ciencia3 S.A., 2002 (ISBN: 84-95391-01-05)

- Claudio Mataix, “Mecánica de fluidos y máquinas hidraulicas” , 2ª ed.,Ediciones del Castillo S.A., Madrid 1986 (ISBN: 84-219-0175-3).

-V.L. Streeter, E.Benjamin, K.W. Bedford, “Mecánica de los fluidos”, Ed. McGraw-Hill, 9ª ed., 2000 (ISBN: 968-600-987-4).

-Irving H. Shames, “Mecánica de fluidos”, Ed. McGraw-Hill, 1995

Advanced references:

-Bruce E. Larock, Roland W. Jeppson, “Hydraulics of pipelines systems”. Ed. CRC Press. 2000 (ISBN: 0-8493-1806-8).

-Frank M.White, “Fluid Mechanics”, Ed. McGraw-Hill, 1986