Teaching guide

IDENTIFICATION DETAILS

Degree:	Industrial and Systems Engineering
Scope	Industrial engineering, mechanical engineering, automatic engineering, industrial organization engineering and navigation engineering
Faculty/School:	Higher Polytechnic School
Course:	FLUID MECHANICS
Type:	Compulsory
ECTS credits:	6
Year:	3
Code:	5730
Teaching period:	Fifth semester
Subject:	Fluid Engineering
Module:	Common to the Industrial Engineering Branch
Teaching type:	Classroom-based
Language:	Inglés
Total number of student study hours:	150

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SUBJECT DESCRIPTION

The fluid mechanics is the branch of science and engineering in charge of studying the continuous media known as fluid. Most of the existing matter in the Universe is fluid: the atmosphere, the oceans and even life cannot be explained without the fluid media. The industrial engineer needs to understand the basic laws of a fluid, paying attention to the energy contained by a fluid and that can be used for different objectives: Turbines, compressors,

piping systems and all kinds of human designs used for improving prosperity.

Fluid mechanics relies on physics and mathematics. Furthermore, it is a branch of mathematical-physics based on particular analysis and experiments. Along the subject, we will explore the analytic and applied concepts to engineering.

The subject is devided into two fundamental areas: The first area is related with the engineering basis of fluid mechanics. We provide models concerning those variables of interest for the engineer (for instance the concept of energy and enthalpy). In the second area, we stress out the basis of the fluid dynamics provided by physics as a support to engineering. We will study the conservation laws in differential and integral forms and we will present the Navier-Stokes equations.

Let us think on an example. Think on the design of an aero-generator whose objective is to extract energy from the wind. According to the first area of the subject (fluid engineering), we will be able to determine the power and energy extracted from the machine. If we employ the second area knowledge (fluid physics), we can understand the behavior of the air around the machine blades and the pressure distribution. The knowledge of the pressure distribution is a fundamental topic to design the blades with the proper geometry and materials.

GOAL

The objective of the subject is the knowledge of the basic laws that govern fluids, as well as their relationship with the specific machinery that will be the object of study for the industrial engineer in other more specific subjects on thermal machines. The course aims to focus on the science of fluids as a support for industrial engineering, thus promoting a taste for understanding industrial systems based on fluid principles.

PRIOR KNOWLEDGE

Fluid mechanics is formulated on mathematical and physical concepts, therefore, it is recommended to have passed a first training in mathematics and physics. In addition, it is recommended to have attended a first course in thermodynamics.

COURSE SYLLABUS

Block A: Fluid engineering.
1. Introduction to fluids: - Definition of fluid. - Units in a fluid. - Viscosity. - Reynolds number. - Equations of fluid statics.
2. Fluid kinematics: - Integral relationships of a fluid - Control volumes. - Mass and volumetric flows. - The Reynolds transport theorem. - One-dimensional approximation of a moving fluid. - The equation of conservation of mass.
3. Basic equations of flowing fluids: - Energy balances and pressure/head losses. - Typical problems of flowing fluids.
4. Incompressible flow in pipes: - Friction in pipes. - Boundary layer. - Fanning and Darcy coefficients. - Fluid regimes. Laminar and turbulent flows. - Unsteady flow. - Industrial piping systems. - Execution of a design of a

piping system.
5. Principles of turbomachinery: - Positive displacement pumps. - Rotary pumps - Equations of the rotary pumps. - Cavitation and suction height. - Rules of similarity - Pumps and systems applied. - Gas compressors. - Francis turbines.
Block B: Physical principles of fluid mechanics.
6. Integral relations of a fluid: - The equation of conservation of linear momentum. - The equation of energy conservation.
7. Differential relations of a fluid: - Eulerian and Lagrangian definitions of a fluid. - Fields of speed and acceleration. - Differential equations for the conservation of mass and momentum. 8. Unsteady fluids: - Compressible flows. - Shock waves. - Friction and heat transfer in compressible flows.
Block C: Open channel flow.

EDUCATION ACTIVITIES

The subject contains a balance between theory and applications:
- Theory and practical sessions: we will expose the key concepts. The sessions are focused on the concept of 'open' class focused on the interaction between teacher and alumni and between alumni.
- Practical sessions: we will develop different real applications focused on engineering projects. The intention is to end a collaborative class where discussions are the basis for knowledge interchange.
- Laboratory: The laboratory sessions will cover different applications of the theory. In addition, several engineering activities will be presented for open debate and discussion. The alumni shall follow an important autonomous work to develop the knowledge and competences related with fluid mechanics: - Individual work: project outcomes and short exercises elaboration.
- Group work: collaborative project outcomes. The teacher will guide the students to work via face-to-face or online mentoring. In addition, the Virtual Classroom platform will be used to share class material.

DISTRIBUTION OF WORK TIME

TEACHER-LED TRAINING ACTIVITIES	INDIVIDUAL WORK
60 Horas	90 Horas
• Theoretical sessions 20h • Seminars 5h • Presentations 5h • Practical sessions 10h • Laboratories 10h • Mentoring 5h • Exams & evaluations 5h	• Student individual work 65h • Group work 25h

LEARNING RESULTS

CRI2 - Knowledge of the basic principles of fluid mechanics and their application to problem solving in the field of engineering. Calculation of pipes, channels and fluid systems.

SPECIFIC LEARNING RESULTS

Calculation of energy balances for open and closed fluid systems. Sizing of fluid-conducting systems.

Learning outcomes include solving exercises and tests that help to understand the principles underlying fluid mechanics from the perspective of the operation and design of pumps and turbines as essential machinery for the industrial engineer.

LEARNING APPRAISAL SYSTEM

ORDINARY CALL
Active Participation (PA): Assigned score: 0.5/10. Typology: individual Development: within the classroom. Description: Active participation in class, interest, collaboration, attention, asking questions, meeting deadlines, etc. Deliverable: Minimum score does not apply to pass the subject: no minimum score is required.
Theoretical-Practical Projects and Activities (TP): Assigned score: 1/10. Typology: individual and group. Development: inside and outside the classroom. Description: carrying out practical problems or exercises in the classroom or as a task outside it, with or without notes, in order to keep the student's attention in class, verify the follow-up of the explanations and encourage the student's training, work and continuous study throughout the course. Deliverable: problems, exercises, jobs or projects. In the case of a project, the final report and the exhibition will be weighted in the same way. Minimum score to pass the subject: no minimum score is required.
Practices and Laboratories (PL): Assigned score: 1.5/10. Typology: individual and group. Development: inside and outside the classroom. Description: carrying out activities focused on the application of the knowledge acquired in the theoretical-practical sessions. Deliverable: problems, exercises, work... Minimum score to pass the subject: 0.75/1.5.
Theoretical partial knowledge tests (PCP): Assigned score: 7/10. Typology: individual. Development: inside the classroom. Description: tests to evaluate the acquisition of knowledge and competencies that the student has acquired during the development of the subject. Deliverable: written test. Minimum average score of the PCP in order to pass the subject: 3.5/7, and it is also essential to obtain at least 4/10 in all the PCP that are taken.
Theoretical-practical global knowledge test (GPC): If the average of the PCP is not equal to or greater than 3/6, the PCP in which less than 4/10 has been obtained must be repeated in the GCP. This test will be divided into as many parts as PCP has had the subject, with the same score and minimum score as the PCP, and the student will be presented: Mandatory to those PCP in which he has not obtained at least 4/10. Voluntarily to the two PCP if you have obtained an average equal to or greater than 3/6 (and at least 4/10 in each of the PCP), you want to improve the grade for that part of the subject. The best score will be counted between the average of the PCP performed during the course and that of the PCG. Practices and Laboratories (PL): those students who do not do their internships during the course, or do not exceed the minimum grade, must complete all the Practices Reports proposed to them previously by the teacher in the ordinary exam. The subject will be approved in an ordinary call when the sum of all the scores assigned to each block is equal to or greater than 5 points. In addition, it will be necessary to obtain the required minimum scores.
EXTRAORDINARY CALL
In the extraordinary call, the student must submit to those parts of the subject in which they have not obtained the required minimum score (except for the PA and TP parts that are not recoverable). The subject will be approved in an extraordinary call when the sum of all the scores assigned to each block is equal to or greater than 5 points. In

addition, it will be necessary to obtain the required minimum scores.

Those students who are exempt from the obligation to attend class (academic exemption), either for second enrollment in the subject or after, or because they have express authorization from the Degree Management, will be evaluated by the same type of tests (PCP and PCG). The PA/TP percentage will be distributed over the corresponding PCPs in the subject. The academic exemption does not exempt from the obligation to carry out laboratory internships (PL).
Any type of fraud or plagiarism on the part of the student in an evaluable activity will be sanctioned as set out in the UFV Coexistence Regulations. For these purposes, any attempt to defraud the evaluation system, such as copying exercises, exams, practices, works or any other type of delivery, either from another colleague, or from unauthorized materials or devices, in order to make the teacher believe that they are his own, will be considered “plagiarism”.

ETHICAL AND RESPONSIBLE USE OF ARTIFICIAL INTELLIGENCE

1.- The use of any Artificial Intelligence (AI) system or service shall be determined by the lecturer, and may only be used in the manner and under the conditions indicated by them. In all cases, its use must comply with the following principles:
a) The use of AI systems or services must be accompanied by critical reflection on the part of the student regarding their impact and/or limitations in the development of the assigned task or project.
b) The selection of AI systems or services must be justified, explaining their advantages over other tools or methods of obtaining information. The chosen model and the version of AI used must be described in as much detail as possible.
c) The student must appropriately cite the use of AI systems or services, specifying the parts of the work where they were used and describing the creative process followed. The use of citation formats and usage examples may be consulted on the Library website(https://www.ufv.es/gestion-de-la-informacion_biblioteca/).
d) The results obtained through AI systems or services must always be verified. As the author, the student is responsible for their work and for the legitimacy of the sources used.
2.- In all cases, the use of AI systems or services must always respect the principles of responsible and ethical use upheld by the university, as outlined in the Guide for the Responsible Use of Artificial Intelligence in Studies at UFV. Additionally, the lecturer may request other types of individual commitments from the student when deemed necessary.
3.- Without prejudice to the above, in cases of doubt regarding the ethical and responsible use of any AI system or service, the lecturer may require an oral presentation of any assignment or partial submission. This oral evaluation shall take precedence over any other form of assessment outlined in the Teaching Guide. In this oral defense, the student must demonstrate knowledge of the subject, justify their decisions, and explain the development of their work.

BIBLIOGRAPHY AND OTHER RESOURCES

Basic

Yunus A. Çengel, John M. Cimbala Fundamentals and Applications (SI units) 4th
(Yunus A. Çengel, John M. Cimbala Fundamentals and Applications (SI units) 4th , McGraw Hill, 2018)

Additional

Frank M. White. Fluid Mechanics/8th. ed. McGraw-Hill.,2016

I. G. Currie. Fundamental mechanics of fluids/Fourth edition. 2013

Allan D. Kraus, James R. Welty, Abdul Aziz. Introduction to thermal and fluid engineering/2011