Teaching guide

IDENTIFICATION DETAILS

Degree:	Industrial and Systems Engineering
Field of Knowledge:	Engineering and Architecture
Faculty/School:	Senior Polytechnic School
Course:	FLUID MECHANICS
Type:	Compulsory
ECTS credits:	6
Year:	3
Code:	5730
Teaching period:	Fifth semester
Area:	Fluid Engineering
Module:	Common to the Branch of Industrial Engineering
Teaching type:	Classroom-based
Language:	English
Total number of student study hours:	150

Teaching staff	E-mail
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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 kind of human designs used for improving prosperity.

The fluid mechanics relies on the physics and mathematics. Furthermore, it is a branch of the 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 the 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 the first area of the subject (fluid engineering), we will be able to determine the power and energy extract from the machine. If we employ the second area knowledge (fluid physics), we can understand the behaviour 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 to improve our knowledge on the basic principles of a fluid used for designing machinery such us thermal engines or generators.

PRIOR KNOWLEDGE

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

COURSE SYLLABUS

1. The concept of a fluid
-Definition of a fluid
-Dimensions in a fluid
-Viscosity
-The Reynolds Number
-Fluidstatics

2. Basic equation of flowing streams
-Total Energy Balance
-Compilation of problems

3. Flow of incompressible fluids in pipes
-Friction in pipes
-The Fanning friction factor
-Flow Regimes
-Piping systems
-Compilation of Problems

4. Turbomachinery
-Archimedes` screw pump
-Positive Displacement Pump (PDP)
-Rotary Dynamic Pumps (RDPs)
-Rotary Dynamic general equations
-Cavitation in pumps
-Net Positive Suction Head (NPSH).
-Similarity rules
-Matching pumps to system characteristics
-Gas Compressors
-Turbines
-Francis Turbines

5. Integral relations of a fluid
-Systems versus Control Volumes
-Volume and Mass Rate of Flow
-The Reynolds Transport Theorem (RTT)
-One-Dimensional Flux Term Approximations

-The conservation of mass
-The Linear Momentum Equation
-The Energy Equation
-Problems

6. Differential relations of a fluid
-Eulerian and Lagrangian definitions of a fluid motion
-Velocity and acceleration fields
-Differential equation for the conservation of mass
-The Differential Equation of the Linear Momentum
-Problems

7. Non-stationay fluids
-Definition
-The phenomena of “Travelling waves”
-The Joukowski differential equation (JDE)

EDUCATION ACTIVITIES

NOTE: the activities and the associated planning can be modified and adapted in accordance with the different scenarios adopted by the sanitary authorities.

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 professor and alumni and between alumni.

- Practical sessions: we will develop different real applications focused on engineering projects. The intention is to enhace 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 professor will guide the students 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

CLASSROOM-BASED ACTIVITY	INDEPENDENT STUDY/OUT-OF-CLASSROOM ACTIVITY
60 hours	90 hours
Theoretical session 20h Seminars 5h Presentations 5h Practical Sessions 10h Laboratories 10h Mentoring 5h Evaluations 5h	Student individual work 65h Group work 25h

SKILLS

Basic Skills

Students must have demonstrated knowledge and understanding in an area of study that is founded on general secondary education. Moreover, the area of study is typically at a level that includes certain aspects implying knowledge at the forefront of its field of study, albeit supported by advanced textbooks

Students must be able to apply their knowledge to their work or vocation in a professional manner and possess skills that can typically be demonstrated by coming up with and sustaining arguments and solving problems within their field of study

Students must have the ability to gather and interpret relevant data (usually within their field of study) in order to make judgments that include reflections on pertinent social, scientific or ethical issues

Students must be able to convey information, ideas, problems and solutions to both an expert and non-expert audience

Students must have developed the learning skills needed to undertake further study with a high degree of independence

General Skills

Knowledge in basic and technological subjects, which enables them to learn new methods and theories, and gives them versatility to adapt to new situations

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

Specific skills

Knowledge of the basic principles of fluid mechanics and its application to solving problems in the field of engineering. Calculation of pipes, channels and fluid systems

LEARNING RESULTS

The students will understand the basis for problems resolution in fluid mechanics and will know the basic concepts typical of engineering projects, such as: energy balances in open and close fluid systems, energy transmission between fluids and solids and sizing of piping systems. In addition, the students will understand the basic principles of turbomachinery, pumps and turbines.

LEARNING APPRAISAL SYSTEM

ORDINARY ASSESSMENT

Active Participation (AP):

Mark: 0,5/10
Typology: Individual
Development: In class
Description: The student shall have an active attitude and shall promote the knowledge interchange.
Delivery: not applicable
Minimum mark to pass: 0/0,5

Theory and Practical sessions (TP)

Mark: 2/10
Typology: Individual and groups
Development: In and out class
Description: Problems formulation and resolution within a project.
Delivery: Technical Notes, exercises or presentations.
Minimum mark to pass: 0,8/2

Practices and laboratories (PL):

Mark: 1,5/10
Typology: Individual and groups
Development: In and out class
Description: Activities focused on the application of knowledge to real problems.
Delivery: Technical Notes.
Minimum mark to pass: 0,6/1,5

Partial Tests (PT):

Mark: 6/10
Typology: Individual
Development: In class
Description: Tests to assess alumni knowledge adquisition.
Delivery: Written paper
Minimum mark to pass: 3/6. In case of more than one PT, it is required to have at least 2,5/10 on those failed TP.

Global Test (GT):

If the mean of all PT is not at least 3/6, all failed TP shall be repeated in the GT. Note that the GT will be divided according to the different PT done. In addition, it is allowed to repeat any passed PT in case any student wishes to improve the PT mark

The subject is considered as passed if the mean of each proof is at least 5/10 provided all minimum marks required are achieved.

EXTRAORDINARY ASSESSMENT

The students shall do all those parts failed (except the AP which is not recoverable). Note that the PT will consist on a unique proof that will covered the whole course.

The subject is pass provided the mean of all the different parts is at least 5/10 provided all minimum marks required are achieved.

For those students without assitance obligation, the mark will be obatined based on the PT and GT only.

NOTE: In case of online sessions due to the sanitary emergency case, the academic assessment of AP, TP and PL will be done with digital means. The PT and GT are kept face-to-face at the university campus.

BIBLIOGRAPHY AND OTHER RESOURCES

Basic

Fluid Mechanics. 7th Edition. Frank M- White. Mc Graw Hill (2011). ISBN 9780073529349

Additional

Fluid Dynamics (an introduction). Michel Rieutord. Springer (2015). ISBN 9783319093505

Mecánica de fluidos. Fundamentos y aplicaciones. Segunda Edición. Yunus Cengel y John Cimbala. Mc Graw Hill (2011). ISBN 9786071507792