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320012 - MF - Fluid Mechanics

Coordinating unit: 205 - ESEIAAT - Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 729 - MF - Department of Fluid Mechanics
Academic year: 2019
Degree: BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN TEXTILE TECHNOLOGY AND DESIGN ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
ECTS credits: 6 Teaching languages: Catalan, Spanish

Teaching staff

Coordinator: Gustavo Raush Alviach

Others: Robert Castilla Lopez
Lluis Domenech
Pedro Javier Gamez Montero
Mercedes Garcia
Hipolit Moreno

Prior skills

SPECIFIC COMPETENCIES
- The ability to understand and apply the basic principles of fluid mechanics.
- The ability to understand and apply the basic principles of fluid mechanics to fluid flow.
- The ability to understand and apply the basic principles of fluid mechanics to energy transport systems (oleohydraulic and pneumatic).
- The ability to understand and apply the basic principles and fundamentals of fluid dynamics to machines and components.

GENERIC COMPETENCIES
- The ability to analyse and understand problems in the field of thermal engineering and fluids.
- The ability to undertake independent learning activities.
- Teamwork.
- The ability to manage time and organise work.

Degree competences to which the subject contributes

Specific:

1. IND_COMMON: Understanding of the basic principles of fluid mechanics and their application in solving engineering problems. The ability to calculate pipes, channels and fluid systems.

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Teaching methodology

- Face-to-face lectures.
- Face-to-face practical work sessions.
- Independent learning and exercises.
- Preparation and completion of group activities subject to assessment.

In the lectures, the lecturer will introduce the theoretical fundamentals of the subject, concepts, methods and results, which will be illustrated with relevant examples to facilitate their understanding.
Practical class work will be covered in four types of sessions:
a) Sessions in which the lecturer will solve problems on the blackboard using techniques, concepts and theoretical results by way of example (40%).
b) Sessions in which the lecturer helps students analyse data and resolve problems. (25%)
c) Sessions in which students sit tests (20%).
d) Sessions in which students give presentations of group work. (5%)
Students will be expected to study in their own time so that they are familiar with concepts and are able to solve the exercises set, whether manually or with the help of a computer.
The test sessions will consist of a multiple choice paper, which will last approximately 45 minutes. Students will mark them in pairs.
Students will work in groups of three on problems that must be handed in. They may be asked to explain their results in applied sessions.

Learning objectives of the subject

Theoretical knowledge
- Students will acquire a basic grounding in the fundamental concept of fluids, their properties and basic laws (principle of mass conservation, amount of movement and energy), as well as the mathematical competences required in the discipline.

Applied knowledge
- Students will put their knowledge into practice by solving standard problems that help to understand and build on the knowledge acquired.

Aptitudes and attitudes
- Students will discover the benefits of learning about fluid mechanics and its applications, which form part of our everyday lives at all levels.
- Students will likewise learn to work, discuss and summarise their findings in groups.

Study load

Total learning time: 150h	Hours large group:	30h	20.00%
	Hours medium group:	15h	10.00%
	Hours small group:	15h	10.00%
	Guided activities:	0h	0.00%
	Self study:	90h	60.00%

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Content

SYLLABUS 1: THE CONCEPT OF FLUIDS	Learning time: 13h Theory classes: 2h Practical classes: 1h Laboratory classes: 2h Self study : 8h

Description:
1.1 Fluids as continuum. Fluid's Definition. Physical Properties of Fluids
1.2 Forces acting on fluids.
1.3 Density and Specific gravity
1.4 Specific weight
1.5 Viscosity: Law of Newton. Newtonian and non-Newtonian fluids
1.6 Compressibility.
1.7 Surface tension
1.8 Perfect gases
1.9 Review of systems of units
1.10 Form

Related activities:
E - Applied exercises
P1 - Ball viscosimetre

Specific objectives:
For students to:
- Define the concept of a fluid.
- Interpret the continuous medium hypothesis.
- Define the concept of a fluid particle.
- Formulate the principal mechanical properties of fluids.
- Give a basic description of the thermodynamics of fluids.
- Define a gas.
- Interpret the continuum hypothesis
- Define surface, mass and linear forces
- Define normal and tangential efforts
- Define surface tension

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SYLLABUS 2. FLUID HYDROSTATIC	Learning time: 11h Theory classes: 2h Practical classes: 2h Self study : 7h

Description:
2.1 Fundamental equations of hydrostatics
2.2 Pressure at a point. Units of pressure. Conversions
2.3 Principle of Pascal
2.4 Hydrostatic of gravity field
2.5 Pushes on a body. Flotation.
2.6 Forces a static fluid on a flat surface
2.7 Barometer. Pressure gauges. Transducers.
2.8 Form

Related activities:
E - Applied exercises

Specific objectives:
- Identify the static balance
- Interpret the fondamental for the fluidoestatica equation
- Manipulate the equation of hydrostatic in the gravity field
- Calculate the pressure at any point in a fluid at rest
- Calculate the forces acting on a flat surface
- Interpret the laws of flotation Archimedes
- Calculate the total floating bodies or partially submerged in fluid
- Describe the methods and instruments for the measurement of the pressure
- Calculate the pressure read on a gauge

SYLLABUS 3: PRINCIPLE OF THE CONSERVATION OF MASS	Learning time: 13h Theory classes: 2h Practical classes: 1h Laboratory classes: 2h Self study : 8h

Description:
3.1 Volumetric and mass flow rate
3.2 Principle of conservation of mass
3.3 Simplifications of the integral equation of conservation of mass
3.4 Mass Balance in stationary flows
3.5 Definition of average speed
3.6 Form

Related activities:
E - Applied exercises
P2 - Velocity profile and ventilator flow measurement

Specific objectives:
For students to:
- Interpret the principle of the conservation of mass using the Reynolds transport theorem.
- Apply the right hypotheses for the simplification of the integral equation of the conservation of mass.
- Define mean velocity.
- Apply the integral equation of the conservation of mass to standard problems.

SYLLABUS 4: PRINCIPLE OF THE CONSERVATION OF ENERGY	Learning time: 11h Theory classes: 3h Practical classes: 2h Self study : 6h

Description:
4.1 Bernoulli Equation
4.2 Deduction of Bernoulli equation
4.3 Static Pressure, dynamic and stagnation
4.4 Hydraulic gradient line and power line
4.5 Form

Related activities:
E - Applied exercises
C - Control test of the knowledge acquired

Specific objectives:
For students to:
- Interpret the principle of conservation of energy
- Describe the different types of existing energy works present in the control surfaces on which there is a fluid flow
- Apply the assumptions necessary for the simplification of the integral equation of conservation of energy and get the Bernoulli equation
- Apply the integral equation of conservation of energy problem type

- Apply the integral equation of the conservation of energy to standard problems.

SYLLABUS 5: BERNOULLI'S EQUATION AND FLOW MEASUREMENT	Learning time: 18h Theory classes: 2h Practical classes: 2h Laboratory classes: 3h Self study : 11h

Description:
5.1 Static Pressure, dynamic and stagnation
5.2 Discharge from a repository through a hole
5.3 Siphon
5.4 Siphon
5.5 Pitot tube
5.6 Prandtl tube
5.7 Venturi tube
5.8 Diaphragm

Related activities:
E - Applied exercises
P4 - Discharge of a tank through an orifice

Specific objectives:
- Differentiate between static pressure, dynamic and total
- Interpret the operation by applying Bernoulli's equation a Pitot tube, a tube of Prandtl, a Venturi tube and a diaphragm
- Define the coefficient of discharge
- Calculate the speed, the theoretical flow rate measurement devices by real and applying the corresponding discharge coefficient
- Calculate the real flow and the download time of a deposit through a hole by applying the corresponding discharge coefficient
- Apply different measuring devices of flow type problems'

SYLLABUS 6: PRINCIPLE OF THE CONSERVATION OF THE QUANTITY OF MOVEMENT	Learning time: 15h Theory classes: 2h Practical classes: 1h Laboratory classes: 3h Self study : 9h

Description:
6.1 External Forces applied on a volume of inertial control
6.2 Force of action and reaction due to the movement of the fluid.
6.3 Application on calculation of forces on an elbow, and turbine blade jets.
6.4 Form

Related activities:
E - Applied exercises
P3 - Quantity of movement

Specific objectives:
For students to:
- Interpret the principle of the conservation of the quantity of movement using the Reynolds transport theorem.
- Recognise the external forces applied on an inertial control volume.
- Apply the right hypotheses for the simplification of the integral equation of the conservation of the quantity of movement.
- Interpret the principle of the conservation of the quantity of movement in an inertial and non-inertial frame of reference.
- Apply the integral equation of the conservation of the quantity of movement in an inertial and non-inertial frame of reference to standard problems.

SYLLABUS 7: DIMENSIONAL ANALYSIS, SIMILARITY AND MODEL THEORY	Learning time: 8h Theory classes: 2h Practical classes: 1h Self study : 5h

Description:
7.1 Introduction
7.2 Dimensional Homogeneity
7.3 Calculation of dimensional groups
7.4 The Buckingham p theorem
7.5 Basic dimensional Numbers
7.6 drag and lift Coefficients: streamlined
7.7 Similarity and model theory
7.8 Experimental Tests
7.9 Form

Related activities:
E - Applied exercises

Specific objectives:
For students to:
- Describe the dimensional analysis method.
- List the advantages and disadvantages of dimensional analysis.
- Identify the dimensional homogeneity of variables in a physical process expressed through an equation.
- Calculate dimensionless groups using Buckingham's pi theorem and/or the matrix of Rayleigh's method.
- Learn the basic dimensionless groups.

SYLLABUS 8: VISCOUS FLOWS IN PIPES I	Learning time: 16h Theory classes: 3h Practical classes: 1h Laboratory classes: 3h Self study : 9h

Description:
8.1. Introduction
8.2. Introduction to boundary layer
8.3. Load loss. Primary and secondary losses. Meaning of the friction coefficient
8.4. The laminar flow regime: Poiseuille's equation
8.5. The turbulent flow regime: the Darcy-Weisbach equation
8.6. Form

Related activities:
E - Applied exercises
P5: Boundary layer

Specific objectives:
For students to:
- Identify primary and secondary losses.
- Interpret the friction coefficient.
- Describe Poiseuille's equation and the Darcy-Weisbach equation.
- Calculate the friction coefficient, and primary and secondary losses in pipes.

SYLLABUS 9: VISCOUS FLOWS IN PIPES II	Learning time: 11h Theory classes: 3h Practical classes: 1h Self study : 7h

Description:
9.1 Determination of the friction coefficient
9.2 The Colebrook equation
9.3 The Moody chart
9.4 Type I : head loss problem
9.5 Type II : flow rate problem
9.6 Type III : sizing problem
9.7 Secondary losses
9.8 Hydraulic radius and the equivalent diameter
9.9 Equivalent length
9.10 Form

Related activities:
E - Applied exercises
C - Control of the knowledge acquired

Specific objectives:
For students to:
- Use a Moody chart.
- Calculate the friction coefficient, and primary and secondary losses in pipes.

SYLLABUS 10: PIPE NETWORKS	Learning time: 11h Theory classes: 3h Practical classes: 1h Self study : 7h

Description:
10.1 Introduction
10.2 Equation of the line of energy charges and loss
10.3 System Equation
10.4 Installation of pipes and tanks
10.5 Pipes in series and parallel
10.6 Form

Related activities:
E - Applied exercises

Specific objectives:
For students to:
- Identify series, parallel, branched and pipe networks.
- Calculate the flow of installations with series, parallel and branched networks.
- Calculate the flow of simple networks.

SYLLABUS 11: FLUID INSTALLATIONS WITH TURBOMACHINERY: PUMPS	Learning time: 14h Theory classes: 3h Practical classes: 1h Laboratory classes: 2h Self study : 8h

Description:
11.1 Point of operation
11.2 Pumps in series
11.3 Pumps in parallel
11.4 Pumps in series in a pipe network
11.5 Pumps in parallel in a pipe network
11.6 Form

Related activities:
E - Applied exercises
P6 - Testing a centrifugal pump

Specific objectives:
For students to:
- Interpret the point of operation in a pump.
- Identify pumps in series and/or in parallel.
- Calculate the flow in installations with pumps in series and/or in parallel.

SYLLABUS 12. OPEN-CHANNEL FLOW	Learning time: 9h Theory classes: 3h Practical classes: 1h Self study : 5h

Description:
12.1 Hydraulic radius
12.2 Open-channel flow classification: Reynolds and Froude numbers
12.3 Manning equation
12.4 Channel geometries
12.5 Critical uniform flow and hydraulic jumps
12.6 Form

Related activities:
E - Applied exercises

Specific objectives:
- Skills to predict flow rates on a given channel geometry
- Developed concepts: hydraulic radius, friction factor and head losses
- Hydraulic jump definition

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Qualification system

- Written tests: 65% (25%: 1st Partial Assessment , 40%: 2nd Partial Assessment)
- Laboratory practice: 15% (10%: participation with attendance, 5%: General content along with the partial 2nd Partial Assessment)
- Controls: 10% (type test hours kind of theory or problem lectures)
- Other: 10% (exercises of application such as: problems, reading articles, reading chapter books, attendance at seminars or conferences, etc.)

For those students who meet the requirements and submit to the reevaluation examination, the grade of the reevaluation exam will replace the grades of all the on-site written evaluation acts (tests, midterm and final exams) and the grades obtained during the course for lab practices, works, projects and presentations will be kept.
If the final grade after reevaluation is lower than 5.0, it will replace the initial one only if it is higher. If the final grade after reevaluation is greater or equal to 5.0, the final grade of the subject will be pass 5.0.

Regulations for carrying out activities

Feedback on examinations

Each exam will consist of two problems with interleaved questions of theory in the general problem statement.

To solve the two problems is allowed to have a form to an A4 sheet on one side and handmade by the student. The use of the calculator is allowed. The use of mobiles is not allowed, smart watches "smartwatches" or similar.

About any of the two problems. The exercises will generally be more decisive than expository and numerical results are often asked. Numerical data should always be expressed in units of YES.

RULES

The review should take place to blue or black pen.

Two problems. It allows a form to an A4 sheet on one side and hand made by the student. Calculator use is permitted. Non cellular phones, smartwatches or similar devices are allowed.

SCORE

Two problems. Each exercise is scored between 0 and 10 points. Within each year may have different sections with their explicit scores.

CRITERIA OF CORRECTION

- To obtain maximum score is needed:
Present the approach and reasoning clearly
Getting the correct numerical result with correct units
Submit the graphs indicating the scales with correct units.
Submit schemes, block diagrams, unambiguously and so on.
- Neatness, conciseness, accuracy and clarity in the presentation will be highly valued. It is good to separate and apart erasers, previous calculations, and so on. Development and resolution that are taken for good. These generally include only need concise comments
- Are penalized heavily so that they can nullify the score on a section:
The dimensional and conceptual errors in reasoning.
The results, expressed in units or no units belonging to YES.
- Numerical errors to bring reasonable results (e.g. in the order of magnitude of the correct result) is only slightly penalized . Other numerical errors, such as a shift or a value meaningless can become considered conceptual errors (e.g. a negative absolute pressure) .
- In questions chained errors arising from the above results are not penalized as long as you take these as data does not represent a conceptual error and the results derived are reasonable.

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