COMILLAS
UNIVERSIDAD PONTIFICIA
ICAI ICADE CIHS

Syllabus
2022 - 2023

GENERAL INFORMATION

Data of the subject	
Subject name	Turbomachines
Subject code	DIM-GITI-431
Mainprogram	Bachelor's Degree in Engineering for Industrial Technologies
Involved programs	Máster Universitario en Ingeniería Industrial y Máster Universitario en Administración de Empresas [First year] Máster Universitario en Ingeniería Industrial [First year] Máster Universitario en Ingeniería Industrial y Máster Universitario en Administración de Empresas [First year] Grado en Ingeniería en Tecnologías Industriales [Fourth year]
Level	Reglada Grado Europeo
Quarter	Semestral
Credits	6,0 ECTS
Type	Optional
Department	Department of Mechanical Engineering
Coordinator	Eva Arenas Pinilla

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DESCRIPTION OF THE SUBJECT

Contextualization of the subject

Prerequisites

There are no prerequisites that formally prevent the course from being taken. However, since it is immersed in a syllabus, it does rely on concepts seen in previous is based on concepts previously seen in previous courses:

- Thermodynamics
- Fluid Mechanics

Course contents

Contents

Chapter 1. Introduction

Fluid machines. Classification of fluid machines. Definition of turbomachine (TM). Classification of TM according to fluid compressibility. compressibility of the fluid. Classification of TM according to the direction of energy transmission. Fluid motion during energy exchange: reference axes, velocities and planes of representation. TM classification according to the direction of flow in the impeller.
the impeller. Energy exchange in the impeller. Euler's equation: kinetic momentum theorem; simplifying assumptions. Triangles of triangles. Energy balance in the exchanger organ: Bernoulli equation; first principle of thermodynamics. Degree of reaction.

Chapter 2. Pumps

2.1. Classification, elements and fundamental parameters.
Types and classification. Limits of entry and exit of the machine. Energy jump in the machine or height between limits in the TMH: effective height. Most relevant geometrical dimensions. Flow equation through the impeller. The diffuser system: function, equations and types. Most relevant constructions and applications.
2.2. Losses, powers and efficiencies.
Classification and study of losses. Efficiencies and powers.
2.3 Pump characteristic curves. Cavitation
The function Hu = Hu(Qrod). Hydraulic losses: graphical representation. The curve H=H(Q). Performance and power curves as a function of flow rate absorbed power as a function of flow rate: analytical forms and graphical representations. Interaction of a rotodynamic pump and the plant: plant characteristic equation: characteristic equation of the system; operating point; regulation by action on the system; operating points of pumps in series and in operating points of pumps in series and in parallel; regulation of pumps in series and in parallel. Cavitation and NPSH, available NPSH and required NPSH.
NPSH required.

2.4. Similarity laws

Similarity in the experimentation with hydraulic models. Velocity coefficients. Conditions for equality of velocity coefficients: equality of velocity triangles; geometric similarity. Pressure and flow coefficients: Conditions for equality. Similarity of pumps: criteria; homologous points. Similarity laws. Specific speed. Applications of similarity laws: specific speed of multiple machines; homologous points in change of size; homologous points in change of speed; scaling. Characteristic fields: by change of speed and by impeller turning. Water hammer and priming.

Chapter 3. Fans

Particular parameters. Constructive forms and applications. Characteristic coefficients and similarity parameters. Curves curves. Fan-installation interaction: characteristic curve of the installation. Regulation. Selection.

Chapter 4. Hydraulic turbines

4.1. Hydroelectric Power Plants

Gross and net head of hydraulic turbines. Application to electric power generation.

4.2. Hydraulic turbines

Reaction turbines: characteristic elements; description of components. Regulation. Francis and Kaplan turbines. Turbines Pelton turbines. Cavitation.

Chapter 5. Thermal turbomachines

Introduction: general characteristics and types of thermal machines. Main equations and their formulations. Scaling of a thermal thermal machine: limits and elements; energy jump; the process in the h-s plane. Classification of losses. Performance and power. Construction details and basic design of thermal machines. Constructive forms and applications. Analysis of fixed crowns: nozzles and reversing inverter crowns. Analysis of mobile crowns: action and reaction staggering; velocity triangles. Staggering pressure and velocity stages: general characteristics and relations between them; number of stages.

EVALUATION AND CRITERIA

Evaluation activities	Evaluation criteria	Weight
Midterm	It will consist of a theory test and problems. If the weighted average grade of 6.5 points, the course will not be released and its weight will be will be 5% of the final grade. If the weighted average grade of 6.5 points is reached, the subject will be released and the final grade will be 40% of the final grade	40 %
Final exam	It will consist of a theory test and problems. If the corresponding subject was not released in the midterm, the weight of this final exam will be 70%. If the corresponding subject was released at the midterm test, the weight of this final exam will be 35%.	35 %

Lab reports and lab work	Compression of concepts. Application of concepts to the resolution of practical problems and to the realization of laboratory practices. Analysis and interpretation of the results obtained in the laboratory practices. Presentation and written communication. Active participation Ability to work in groups.	25 %

Grading

- Ordinary convocation:

  75% of the theory grade:

  Partial exam: Pumps and Fans.

  Grade ≥ 6.5. Released subject of Pumps and Fans.

  Final exam.

  Grade ≥ 6.5 in partial (40%). Turbines and Thermal Exam (35%).

  Grade < 6.5 in partial (5%). Pumps and fans, turbines and thermals exam (70%).

  25% laboratory grade:

  20%: Average grade of the laboratory reports or notebooks.

  5%: Active participation in the performance of the laboratory practices.

  Each exam (partial and final) consists of a test part (30%) and a problem part (70%). A minimum grade of 3.0 in each part is required. If it is not passed, the overall grade of the exam will be the lowest grade obtained (test or problems).

  If a student releases material for the final exam and his theory grade is lower than 5 after the exam, he/she will take the final exam with all the material. exam with all the material.

- In the extraordinary exam, the part failed (theory or laboratory) or that has not passed the minimum grade of the final exam (test or problems) will be examined, as long as the overall grade of the exam is higher than 5), keeping the grade of the part passed (or higher than the grade of the final exam). The weighting criterion is: 25% laboratory (or laboratory exam), 75% of the grade of the exam of the extraordinary exam (or theory grade in the ordinary exam).

  In both exams, the weighted average of theory and laboratory will be made only when both grades are equal or higher than 5.
- Failure to attend more than 15% of the classroom hours of this course may result in the impossibility of taking the regular exam.

WORK PLAN AND SCHEDULE

Activities	Date of realization	Delivery date
Reading and study of the theoretical contents explained in class.	After every class	
Attempt to solve the proposed problems to be carried out in class	Before class	
Review and study of the problems solved in class.	After class	

Attempt to solve problems not done in class, as well as exam problems. Consultation of the solution published in Moodle and request for tutoring if necessary.	After every chapter	
Preparation of the tests to be taken during class hours	After the "hydraulic machines" section	
Final exam preparation	December	
Preparation of laboratory reports	After every lab session	

BIBLIOGRAPHY AND RESOURCES

Basic References

- Claudio Mataix, Turbomáquinas Hidráulicas, Universidad Pontificia Comillas, 2ª edición, 2009.
- Claudio Mataix, Turbomáquinas Térmicas, Ed. Dossat, 3ª edición, 1991
- Powerpoint presentations for every chapter (available in Moodle).
- Solved tests and problems (available in Moodle).
- Solved exams (available in Moodle).