

## DIM-GITI-431 Turbomachines

**SEMESTER:** Fall

**CREDITS:** 6 ECTS (4 hrs. per week: 3 Theory + 1 Lab, on average)

**LANGUAGE:** Spanish

**DEGREES:** GITI

### Course overview

In this course the working principles of various types of turbomachines will be studied: hydraulic (pumps, fans, and hydraulic turbines) and thermal (turbocompressors, steam and gas turbines).

The course focuses on the basic design criteria and their installation problems, their operation and their regulation in various types of facilities. Skills in the operation and measurement of the main operating parameters of turbomachines in the laboratory will be also acquired.

### Prerequisites

Basic knowledge of thermodynamics and fluid mechanics.

### Course contents

#### Theory:

1. Definition and classification of turbomachines. Euler equation: theorem of angular momentum; simplifying assumptions. Velocity triangles.
2. Losses, power and efficiency in hydraulic turbomachinery. Construction details and basic design of rotodynamic pumps. Most relevant geometric dimensions. The diffuser system: function, equations and types.
3. Characteristic curves of rotodynamic pumps. Pump performance curves: analytical and graphical representations forms. Interaction of a rotodynamic pumps and installation: operating point; regulation by acting on the installation; pumps in series and parallel.
4. Affinity laws. Specific speed. Application of the affinity laws: Specific speed of multiple machines; homologous points; scaling. Operation and selection of centrifugal pumps.
5. Cavitation and NPSH. Water hammer and pump priming.
6. Fans. Types and classification: relevant parameters.

7. Hydraulic turbines. Application of hydraulic turbines to electricity generation. Regulation. Francis and Kaplan turbines. Pelton turbines. Cavitation
8. Thermal turbomachines. Introduction: general characteristics and types.

### Laboratory:

There will be six 2-hour sessions in the last weeks.

- P1. Descriptive study of pumps and turbines
- P2. Analysis of the performance of centrifugal pumps
- P3. Analysis of the performance of fans
- P4. Analysis of the performance of hydraulic turbines.
- P5. Cavitation in pumps
- P6. Pumps in parallel/series

### Textbook

- Claudio Mataix, Turbomáquinas Hidráulicas, Universidad Pontificia Comillas, 2ª edición, 2009.
- Claudio Mataix, Turbomáquinas Térmicas, Ed. Dossat, 3ª edición, 1991.

### Grading

A minimum overall grade of at least 5 over 10 must be accomplished to pass the course.

This overall grade is obtained as follows:

- Exams:
  - Mid-Term exam: pumps and fans
  - Final exam:
    - Mid-Term grade  $\geq 6.5$ : Mid-Term (40%), turbines and thermal (35%).
    - Mid-Term grade  $< 6.5$ . Mid-term (5%). pumps and fans, turbines and thermal (70%).
  - Every exam consists of two parts: multiple-choice test (30%) and problems (70%). A minimum grade of 3.0 over 10 must be accomplished in both.
- Laboratory: Reports (20%), Performance during the lab sessions (5%).
- They are weighted: 75% (Exams) and 25% (laboratory) if both parts are  $\geq 5$ .