Course guide
820741 - EHM - Hydropower and Ocean Energy

Last modified: 19/06/2024

Unit in charge: Barcelona School of Industrial Engineering
Teaching unit: 729 - MF - Department of Fluid Mechanics.

Degree: MASTER'S DEGREE IN ENERGY ENGINEERING (Syllabus 2013). (Optional subject).
MASTER'S DEGREE IN ENERGY ENGINEERING (Syllabus 2022). (Optional subject).

Academic year: 2024 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: Mònica Egusquiza

Others:

PRIOR SKILLS

Background in Fluid Mechanics and Hydraulic machinery

TEACHING METHODOLOGY

LEARNING OBJECTIVES OF THE SUBJECT

To understand the electricity demand and generation, the variations in the consumption and the characteristics of the main types of power plants generating energy. To know the advantages and disadvantages of hydro power compared with other types of power plants.

To be aware of the main types of water power systems comparing conventional hydro (peak generation), run-of-river (base generation) and pumped storage. To understand the operation of a hydro power plant. To know the main components of a typical hydro power system and the evolution of the hydraulic energy in it. To use properly and calculate the terms head, power and efficiency. To learn how to calculate the energy produced by a hydropower unit.

To know the main components of a hydropower unit understanding the operation depending on head and guide-vane opening using hill charts. To know the main types of hydraulic turbines (reaction and action machines) with their main characteristics and performance.

To understand the basics of the energy transfer in a hydraulic turbine from the Euler equation. To understand the main flow characteristics in terms of velocity, pressure and dissipation. To learn how to calculate the average velocity fields and the energy converted into mechanical energy by the turbine depending on the operating conditions.

To understand the basics of cavitation phenomena and the main types of cavitation than may occur in hydraulic turbines. Calculation of the turbine setting levels.

To understand the start-up and coast-down transients with the associated problems of runaway speed and water hammer.

To know the methods to extract energy of the seas using tidal plants, marine current turbines and wave energy converters. To know the main types of devices and operating principles.

STUDY LOAD

Type	Hours	Percentage
Guided activities	10,0	8.00
Hours large group	30,0	24.00
Self study	85,0	68.00

Total learning time: 125 h

CONTENTS

Introduction

Description:
- Energy generation and demand
- Advantages and importance of hydropower

Specific objectives:
To understand the electricity demand and generation, the variations in the consumption and the characteristics of the main types of power plants generating energy. To know the advantages and drawbacks of hydropower compared with other types of power plants.

Full-or-part-time: 9h
Theory classes: 2h
Guided activities: 1h
Self study : 6h

Hydropower systems

Description:
- Conventional hydro
- Run-of-river systems
- Pumped storage
- Hydraulic system components
- Trash-racks, valves, penstock, draft tube

Specific objectives:
To be aware of the main types of water power systems comparing conventional hydro (peak generation), run-of-river (base generation) and pumped storage. To understand the operation of a hydro power plant. To know the main components of a typical hydro power system and the evolution of the hydraulic energy in it. To use properly and calculate the terms head, power and efficiency. To learn how to calculate the energy produced by a hydropower unit.

Full-or-part-time: 9h
Theory classes: 2h
Guided activities: 1h
Self study : 6h

Energy transfer

Description:
- Energy parameters
- Head, discharge, power and efficiency
- Turbine energy transfer

Specific objectives:
To understand the basics of the energy transfer in a hydraulic turbine from the Euler equation. To understand the main flow characteristics in terms of velocity, pressure and dissipation. To learn how to calculate the average velocity fields and the energy converted into mechanical energy by the turbine depending on the operating conditions.

Full-or-part-time: 9h
Theory classes: 2h
Guided activities: 1h
Self study : 6h

Hydropower unit components

Description:
- Turbine and generator
- Shaft, coupling
- Bearings and seals

Specific objectives:
To know the main components of a hydropower unit understanding the operation depending on head and guide-vane opening using hill charts.

Full-or-part-time: 9h
Theory classes: 2h
Guided activities: 1h
Self study : 6h

Types of turbines

Description:
- Classification
- Francis
- Kaplan
- Pelton
- Pump-turbines

Specific objectives:
To know the main types of hydraulic turbines (reaction and action machines) with their main characteristics and performance.

Full-or-part-time: 15h
Theory classes: 4h
Guided activities: 1h
Self study : 10h

Cavitation

Description:
- The phenomenon of cavitation
- Types of cavitation
- Cavitation coefficients

Specific objectives:
To understand the basics of cavitation phenomena and the main types of cavitation than may occur in hydraulic turbines. Calculation of the turbine setting levels.

Full-or-part-time: 9h
Theory classes: 2h
Guided activities: 1h
Self study : 6h

Dimensional analysis

Description:
- Non-dimensional groups
- Turbine selection
- Losses and efficiencies

Specific objectives:
To understand the importance and application of dimensional analysis in hydraulic turbines and reduced-scale models tests. To be aware of the main types of non-dimensional groups. To understand the application of non-dimensional numbers for sizing and selection of hydraulic turbines. To learn the different types of losses and efficiencies in hydro units.

Full-or-part-time: 9h
Theory classes: 2h
Guided activities: 1h
Self study : 6h

Transients

Description:
- Transients
- Water hammer
- Emergency stops and runaway speed

Specific objectives:
To understand the start-up and coast-down transients with the associated problems of runaway speed and water hammer.

Full-or-part-time: 15h
Theory classes: 4h
Guided activities: 1h
Self study : 10h

Transients

Description:
- Regulation in hydraulic turbines
- Variable speed
- Hydraulic Short Circuit
- Battery hybrids

Specific objectives:
To understand the importance of regulation in hydro units and the role of the governor. To be aware of the main trends toward the increase of regulation capacity in hydro power plants. To know which are the advantages of variable speed, hydraulic short circuit and batteries

Full-or-part-time: 9h
Theory classes: 2h
Guided activities: 1h
Self study : 6h

Marine energy

Description:
- Energy from the seas
- Tidal energy. Tidal plants. Examples
- Marine currents. Marine current turbines. Classification and types. Horizontal shaft and vertical shaft.
- Waves. Wave devices: Rusell, Pelamins, sea snakes, Wells turbines

Specific objectives:
To know the methods to extract energy of the seas using tidal plants, marine current turbines and wave energy converters. To know the main types of devices and operating principles.

Full-or-part-time: 15h
Theory classes: 4h
Guided activities: 1h
Self study : 10h

GRADING SYSTEM

The students will be evaluated through exercises to be submitted throughout the course (10%), a first midterm exam (45%), and a second midexam at the end of the course (45%).

Students who do not pass the continuous assessment or want to improve their grade will have the option to take a final exam covering all course content.

The final grade for the course will be calculated according to the following formula:

FG = MAX[(ME1*0.45 + ME2*0.45 + EX*0.10); FE]

where FG = final grade for the course, ME1 = grade for the first midterm exam, ME2 = grade for the second midterm exam, EX = grade for submitted exercises, and FE = grade for the final exam.