240EI022 - Hydraulic Machines

Coordinating unit: 240 - ETSEIB - Barcelona School of Industrial Engineering
Teaching unit: 729 - MF - Department of Fluid Mechanics
Academic year: 2017
Degree: MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2014). (Teaching unit Compulsory)
ECTS credits: 4.5
Teaching languages: Catalan, Spanish

Teaching staff
Coordinator: Carme Valero
Others: Eduard Egusquiza
Xavier Escaler
Esteve Jou
Enric Trillas
Andreu Besteran
Monica Egusquiza

Prior skills
The students should have knowledge of Fluid Mechanics

Degree competences to which the subject contributes
Specific:
CEMEI05. Knowledge and ability for the design and analysis of thermal machines and engines, hydraulic machines and heating and cooling plants.

Teaching methodology
Theory classes 2 times a week (one hour/day) and laboratory sessions once a week in alternate weeks throughout the semester.

Learning objectives of the subject
The subject aims to provide basic knowledge on the principles of operation and utilization of hydraulic machines for incompressible flow: pumps, turbines and fans. We study the fundamental equations that govern its operation, the basic design parameters and main applications.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 112h 30m</th>
<th>Hours large group: 30h 30m</th>
<th>27.11%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours small group:</td>
<td>10h</td>
<td>8.89%</td>
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<tr>
<td>Guided activities:</td>
<td>0h</td>
<td>0.00%</td>
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<tr>
<td>Self study:</td>
<td>72h</td>
<td>64.00%</td>
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</table>
## Content

| **INTRODUCTION** | **Learning time:** 1h 30m  
Practical classes: 1h 30m |
<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Hydraulic energy is introduced like an alternative energy and their importance in the real world is emphasized. Fluid machines are classified and their most important applications are showed.</td>
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</table>

| **BASICS. DIMENSIONLESS PARAMETERS AND SIMILARITY.** | **Learning time:** 3h  
Practical classes: 3h |
<table>
<thead>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Basics of head, specific energy and efficiency are introduced. Characteristic curves and the main dimensionless parameters used in turbomachinery are introduced.</td>
</tr>
</tbody>
</table>

| **KINEMATICS IN CENTRIFUGAL TURBOMACHINERY** | **Learning time:** 4h  
Practical classes: 4h |
<table>
<thead>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Flow inside a centrifugal turbomachinery is described. Case of pumps, turbines and centrifugal fans are studied. For each case velocity triangles for design conditions and off-design conditions are studied.</td>
</tr>
</tbody>
</table>

| **KINEMATICS IN AXIAL TURBOMACHINERY** | **Learning time:** 4h  
Practical classes: 4h |
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</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Flow inside a centrifugal turbomachinery is described. Case of pumps, turbines and axial fans are studied. For each case velocity triangles for design conditions and off-design conditions are studied.</td>
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</tbody>
</table>

| **PRINCIPLES FOR INCOMPRESIBLE FLOW. EULER EQUATION.** | **Learning time:** 4h  
Practical classes: 4h |
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>The equation of energy exchange fluid-machine from the kinetic moment equation for ideal flow is deduced. From here the theoretical characteristic curve is obtained. From a number of approaches the actual characteristic curve is calculated, taking into account the losses.</td>
</tr>
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</table>
## HYDRAULIC FORCES IN PUMPS

**Learning time:** 4h  
**Practical classes:** 4h

**Description:**  
The differences in pressure inside the hydraulic impeller generate forces and moments acting on the rotor. The calculation of these forces are important for sizing the shaft and bearings. This chapter explains how to calculate the forces generated in the axial direction and radial direction.

## CONTROL SYSTEMS OF HYDRAULIC TURBOMACHINERY

**Learning time:** 3h  
**Practical classes:** 3h

**Description:**  
Different methods to regulate the flow of turbomachinery once they are incorporated into a piping system are introduced. For each type of turbomachinery the most appropriate control systems (valve serial, bypass, variation of the rotation speed ...) are introduced.

## CAVITATION IN PUMPS AND TURBINES

**Learning time:** 3h 30m  
**Practical classes:** 3h 30m

**Description:**  
We introduce a classical problem in turbomachinery: the problem of cavitation. Describes the phenomenon, different types of cavitation and the characteristic parameters that allow us to calculate the possibility of cavitation in an installation.

## Qualification system

<table>
<thead>
<tr>
<th>Weight</th>
<th>Description</th>
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<tbody>
<tr>
<td>0.2</td>
<td>laboratory</td>
</tr>
<tr>
<td>0.2</td>
<td>midterm exam</td>
</tr>
<tr>
<td>0.6</td>
<td>final exam</td>
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</tbody>
</table>

To do the recovery test is mandatory final exam

## Regulations for carrying out activities

All parts are evaluated are mandatory.
Bibliography

**Basic:**

