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Course guide
340208 - MATH-M7P29 - Heat and Hydraulic Engines I

Last modified: 02/07/2023

Unit in charge:	Vilanova i la Geltrú School of Engineering
Teaching unit:	729 - MF - Department of Fluid Mechanics.

Degree: BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Optional subject).

Academic year: 2023   **ECTS Credits:** 6.0   **Languages:** Catalan

LECTURER

Coordinating lecturer: JAUME MIQUEL MASALLES

Others: JAUME MIQUEL MASALLES
FERNANDO GARCIA GONZALEZ
DAVID MORENO MAESTRO

PRIOR SKILLS

It is recommended to have:
Knowledge of Fundamentals of Thermal Engineering
Knowledge of Fluid Mechanics
Knowledge of Thermal Engineering
Knowledge of Fluid Engineering

REQUIREMENTS

It is recommended to have taken the following subjects (or at least have taken one subject from the Thermal area and another from the Fluids area):
340038 - Fundamentals of Thermal Engineering
340039 - Fluid Mechanics
340056 - Thermal Engineering
340058 - Fluid Engineering

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. CE21. Applied thermal engineering knowledge.
2. CE24. Applied basic knowledge of fluid mechanical systems and machines.

Transversal:
3. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.
4. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 3. Communicating clearly and efficiently in oral and written presentations. Adapting to audiences and communication aims by using suitable strategies and means.
6. TEAMWORK - Level 3. Managing and making work groups effective. Resolving possible conflicts, valuing working with others, assessing the effectiveness of a team and presenting the final results.
7. EFFECTIVE USE OF INFORMATI0N RESOURCES - Level 3. Planning and using the information necessary for an academic assignment (a final thesis, for example) based on a critical appraisal of the information resources used.

TEACHING METHODOLOGY

- IMPARTITION OF KNOWLEDGE: Lectures and participatory classes, consisting of explanation and development of the theory and, if necessary in the resolution of problems. The material user will be available to the student in the Digital Campus section of the subject.

- APPLIED APPRENTICESHIP OF KNOWLEDGE: Practical sessions of resolution of problems where the maximum participation of the student will be tried, through his direct implication in the resolution of exercises. This will give rise to the activity of "Delivery of Exercises". The student will have in advance in the section of the Digital Campus enabled for the subject of the collection of problems to be carried out.

- DELIVERY OF EXERCISES: Delivery of problems solved by students. The deliveries will consist of the individual resolution, to be done in class and/or out of class, of any problem/s of the list of problems, or similar to those of the list, that the student will have the Digital Campus. This activity will have evaluative weight and for its realization a rubric will be available. Efforts will be made to give the note of the delivery of the problems in a reasonable time so that the student can reorient their work in case it is not satisfactory.

- LEARNING FROM EXPERIMENTATION AND SIMULATION: Practical laboratory sessions and simulation practices, carried out directly by the students, guided by the teacher, which will allow them to observe directly relevant aspects of the theory developed. The scripts of the practices to be developed will be available, before their realization, in the section of the Digital Campus enabled for the subject. The students will give the teacher a copy of the experimental data obtained. Subsequently, students must make a report, by group, of the practice carried out. For its realization the students will have a rubric in the Digital Campus referring to the preparation of the internship reports. These reports will have an evaluative weight and must be submitted, by groups, before the date indicated by the professor through the digital campus.

- SELF-DIRECTED LEARNING GUIDES: Preparation and written presentation of two (or three) sections of Topic 1 and Topic 6 of the subject respectively. This constitutes Practice 1 and Practice 5 of the subject. The student must work individually or in groups of 2 students two (or three) sections of Topic 1 and Topic 6 of the subject assigned by the teacher. You will have the objectives, the sections to develop and a reference bibliography to consult. The group must be able to decide how it should be organized and know how to identify the sources of information. The presentation of the activity will be done in writing (as the report of Practice 1 and Practice 5 respectively) and will have an evaluative weight.

- TUTORIALS: Individual tutorials (or collective where appropriate) that will allow the student to solve any doubts that may have on the subject for an effective follow-up of the subject.

- INDIVIDUAL WRITTEN TESTS: The students will perform two partial controls of all the knowledge of theory and problems developed in the subject. The first partial control (CP1) will be done halfway through the semester and will be related to Thermal Machines, and the second partial control (CP2) will be carried out at the end of the semester (Final Evaluation period) and will be related with the Hydraulic Machines. There will be a Final Control of the subject (CFinal) in the Final Evaluation period. Students with a grade of CP1 lower than 3.5 can be presented in an optional way to this Final Control, which will replace CP2.

LEARNING OBJECTIVES OF THE SUBJECT

At the end of the course students should be able to:

1. Identify and evaluate the variables that characterize the thermal and hydraulic machines.

STUDY LOAD

Type	Hours	Percentage
Hours large group	52,5	35.00
Hours small group	7,5	5.00
Self study	90,0	60.00

Total learning time: 150 h

CONTENTS

1. HEAT ENGINES: INTERNAL COMBUSTION ENGINES

Description:
1.1. General classification of thermal machines and heat engines (external and internal combustion engines). Basic components of an internal combustion engine (ICE). Main fields of application of the ICE.

Specific objectives:
At the end of this teaching unit, the student should be able to:

Related activities:
A1. Problems of internal combustion engines (ICE).

Full-or-part-time: 30h 15m
Theory classes: 10h 30m
Laboratory classes: 1h 45m
Self study : 18h

2. COMPRESSORS

Description:
2.1. Introduction. General classification of the compressors. Scope of various types of compressors. Practical applications of compressors.

Specific objectives:
At the end of this teaching unit, the student should be able to:

Related activities:
A2. Problems of compressors.

Full-or-part-time: 20h 30m
Theory classes: 7h 30m
Self study : 13h

3. STEAM TURBINES AND GAS TURBINES

Description:
3.1. Power cycles with steam turbines:

Specific objectives:
At the end of this teaching unit, the student should be able to:

Related activities:
A3. Problems of steam turbines and gas turbines.

Full-or-part-time: 25h 15m
Theory classes: 8h 45m
Laboratory classes: 2h 30m
Self study : 14h

4. FUNDAMENTALS OF HYDRAULIC MACHINES

Description:
4.1. Definición y clasificaciones de Máquinas Hidráulicas
4.2. Teoría general de las Turbomáquinas Hidráulicas
4.2.1. Triángulos de velocidad.
4.2.2. Ecuación fundamental de las turbomáquinas hidráulicas.
4.2.3. Grado de reacción
4.2.4. Pérdidas en las turbomáquinas.
4.2.5. Comportamiento real de las turbomáquinas hidráulicas.
4.3. Semejanza en Turbomáquinas Hidráulicas.

Specific objectives:
At the end of this teaching unit, the student must be able to:

Related activities:
A9. Problems of fundamentals of Hydraulic Machines.

Full-or-part-time: 22h
Theory classes: 8h 30m
Self study : 13h 30m

5. PUMPS AND FANS

Description:
5.1. Bombas Hidráulicas: Introducción y Clasificación
5.1.1. Turbobombas (bombas rotodinámicas).
5.1.1.1. Clasificaciones y elementos constitutivos. Equipamiento hidráulico.
5.1.1.2. Curvas características.
5.1.1.3. Forma y número de álabes del rodete.
5.1.1.4. Funcionamiento a velocidad angular variable.
5.1.1.5. Recorte del rodete
5.1.1.6. Cavitación.
5.1.1.7. Selección de una bomba. Influencia de la viscosidad del fluido.
5.1.1.8. Golpe de Ariete.
5.1.2. Bombas de Desplazamiento Positivo.
5.1.2.1. Fundamentos. Clasificación.
5.1.2.2. Bombas alternativas.
5.1.2.3. Bombas rotoestáticas.
5.2. Ventiladores.
5.2.1. Definición y clasificaciones de ventiladores.
5.2.2. Fórmulas fundamentales de ventiladores.
5.2.3. Efecto de la compresibilidad del gas en el diseño de ventiladores.
5.2.4. Acoplamiento de ventiladores.
5.3. Regulación de bombas y ventiladores.

Specific objectives:
At the end of this teaching unit, the student must be able to:
- Identify the different types of pumps, understand how it works and know its scope of application.

Related activities:
A6. Practice 3. "Study of the performance of a centrifugal fan with different impellers. Study of instabilities of a fan."

Full-or-part-time: 29h
Theory classes: 10h 45m
Laboratory classes: 1h 45m
Self study : 16h 30m

6. HYDRAULIC TURBINES

Description:
6.1. Centrales Hidroeléctricas. Elementos constitutivos.
6.2. Generalidades de Turbinas Hidráulicas.
6.3. Turbinas Hidráulicas de Acción.
6.3.1. Elementos de una Turbina Pelton.
6.3.2. Triangulos de velocidades de una Turbina Pelton.
6.3.3. Velocidad Específica en una Turbina Pelton.
6.3.4. Selección de una Turbina Pelton.
6.4. Turbinas Hidráulicas de Reacción.
6.4.1. Diagrama de transformación de energía de una Turbina Hidráulica de Reacción.
6.4.2. Elementos de una Turbina Hidráulica de Reacción
6.4.3. Tipos de Turbinas Hidráulicas de Reacción.
6.4.4. Velocidad Específica en una Turbina Francis.
6.4.5. Cavitación en Turbinas Hidráulicas.

Specific objectives:
At the end of this teaching unit, the student should be able to:

Related activities:
A11. Problems of Hydraulic Turbines

Full-or-part-time: 23h
Theory classes: 8h
Self study : 15h

GRADING SYSTEM

The evaluation weight of the different concepts involved in the qualification of the subject are:
- INDIVIDUAL WRITING TESTS: 60 %
- DELIVERY OF SOLVED PROBLEMS: 20 %
- PRACTICES REPORTS (WORKS, LABORATORY AND SIMULATION): 20 %

To obtain the final grade of MATH the following equation of the evaluation will be applied:

[1] Final Note of MATH = Note CP1*0.30 + Note CP2*0.30 + Note Delivery Problems*0.20 + Note Practices*0.20

Students who have obtained a grade lower than 3.5 in the Note of CP1, may be presented as an optional to a Final Control (CFinal) instead of CP2. This CFinal will be held on the same day and time as the CP2, within the Final Evaluation Period. The equation of the evaluation, to obtain the final grade of MATH, in this case is:

[2] Final Note of MATH = Note CFinal*0.60 + Note Delivery of Problems*0.20 + Note Practices*0.20

There are no minimum notes in any of the previous evaluative acts at the time of applying equations [1] or [2].

Given that the subject of MATH is optional, in accordance with page 17 of the Academic Regulations of the Degree and Master's Studies of the EPSEVG of the 2023/24 Course, there will be no Reevaluation.

EXAMINATION RULES.

- Each of the two individual written tests (Partial Controls), will consist of two parts: a theory test (which will constitute 30% of the grade of the 1st test and 20% of the grade of the 2nd test) and a certain number of problems (until completing 100% of the test grade). Both tests have the same evaluative weight (30%). A minimum grade of the partial controls is not required.

- The Final Control (CFinal) will consist of two parts: the first part of Thermal Machines will be worth 5 points and will consist of a theory test (which may constitute up to 30% of the note of this part) and a certain number of problems (until completing 100% of the note of this part). The second part of Hydraulic Machines will be worth 5 points and will consist of a theory test (which may constitute up to 20% of the grade of this part) and a certain number of problems (until completing 100% of the grade of this part). A minimum grade of the Final Control is not required.

- Deliveries of problems solved individually, will be evaluated following the rubric for the delivery of problems, which the student will have in advance. The problems solved must be delivered by the Digital Campus within the time period assigned by the teacher.

- The practices reports (works, laboratory and simulation) will be evaluated according to the rubric established for the realization of the same and that the students will have previously. To have a note of a certain laboratory practice (or simulation) it is essential to have done the practice in person and present the report with the group with which the practice was carried out in the laboratory (or in the computer room).

- If a student does not show up to any of the two partial controls (or the final control), but presents problems and / or practices delivery, at the end he / she will have a note of the subject.

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