Course guide
240171 - 240171 - Heat Technology

Unit in charge: Barcelona School of Industrial Engineering
Teaching unit: 724 - MMT - Department of Heat Engines.

Degree: BACHELOR’S DEGREE IN INDUSTRIAL TECHNOLOGY ENGINEERING (Syllabus 2010). (Compulsory subject).
BACHELOR’S DEGREE IN AUTOMOTIVE ENGINEERING (Syllabus 2017). (Optional subject).

Academic year: 2022  ECTS Credits: 6.0  Languages: Catalan

LECTURER

Coordinating lecturer: Ruiz Mansilla, Rafael
Others: Bonals Sastre, Gorka
Capdevila Paramio, Roser
García Mónaco, Alejandro
Martínez Ballester, Santiago
Mas de les Valls, Elisabet
Ruiz Mansilla, Rafael

REQUIREMENTS

Thermodynamics and Fluid Mechanics

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Capacity to understand and apply basic knowledge principles of general chemistry, organic and inorganic chemistry and their engineering applications.
2. Capacity to solve mathematical problems that can appear in engineering. Aptitude to apply knowledge about: linear algebra; geometry; differential geometry; differential and integral calculus; differential equations and derived partial equations; numerical methods; numerical algorithm; statistics and optimisation.
3. Understanding and dominion of basic concepts on mechanics, thermodynamics, fields and waves and electromagnetism laws and their application to solve engineering problems.
4. Knowledge on applied thermodynamics and heat transfer. Basic principles and their application to solve engineering problems.
5. Knowledge of basic principles of mechanical fluids and their application to solve engineering problems. Calculation of pipes, channels and systems of fluids.
6. Basic knowledge applied to environmental and sustainability technologies.
7. Basic knowledge on the use and programming of computers, operative systems, data bases and computer software with an engineering application.
Transversal:

8. SELF-DIRECTED LEARNING. Detecting gaps in one's knowledge and overcoming them through critical self-appraisal. Choosing the best path for broadening one's knowledge.

9. EFFICIENT ORAL AND WRITTEN COMMUNICATION. Communicating verbally and in writing about learning outcomes, thought-building and decision-making. Taking part in debates about issues related to the own field of specialization.

10. ENTREPRENEURSHIP AND INNOVATION: Knowing about and understanding how businesses are run and the sciences that govern their activity. Having the ability to understand labor laws and how planning, industrial and marketing strategies, quality and profits relate to each other.

11. SUSTAINABILITY AND SOCIAL COMMITMENT. Being aware of and understanding the complexity of social and economic phenomena that characterize the welfare society. Having the ability to relate welfare to globalization and sustainability. Being able to make a balanced use of techniques, technology, the economy and sustainability.

12. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.

13. TEAMWORK. Being able to work as a team player, either as a member or as a leader. Contributing to projects pragmatically and responsibly, by reaching commitments in accordance to the resources that are available.

14. EFFECTIVE USE OF INFORMATION RESOURCES. Managing the acquisition, structure, analysis and display of information from the own field of specialization. Taking a critical stance with regard to the results obtained.

TEACHING METHODOLOGY

Classes combine theory and problems, case analysis and technical decision-making, inviting students to participate actively in them. Continued work is encouraged throughout the course with the proposal and collection of problems.

In the face-to-face classes, the theory is presented simultaneously with the explanation of problems that allow the student to delve into the basic concepts of heat transfer. In class presentations, industrial-type images are shown with the purpose of motivating and showing the student the importance of studying this subject; Explain the theoretical concepts and develop the mathematical models of calculation, their restrictions and their scope of application. The problem classes show the correct use of mathematical models, with an increasing degree of difficulty, and special emphasis is placed on the interpretation of the results.

In the laboratory, students have the opportunity to know the devices and methodology for the experimental determination of magnitudes and thermal parameters, to deepen the use of correlations, as well as in the validation of the results obtained by adjusting the balance of energy.

Numerical practice with ANSYS allows an approach to a powerful numerical methods tool to solve a complex driving problem and compare the results with a simplified previously solved analytical or numerical solution.

Homework usually focus on the problem-solving approach. Calculation exercises are proposed for being delivered in paper or using the environment of the ATENEA Campus. Teachers can therefore propose and collect written exercises throughout the course.

At the ATENEA Campus, the student can find study materials. Additionally, for the personal study, the student has notes of the subject and basic bibliography of reference, available in the etseib library. It will also be very useful the notes you will find in the following link,

https://upcommons.upc.edu/handle/2117/364535
LEARNING OBJECTIVES OF THE SUBJECT

Competences of the degree to which the subject contributes

Specific:

1. Know how to determine temperature distributions and heat transfer by conduction, convection and / or radiation in diverse systems.

2. Basic principles and their application to the resolution of engineering problems.

General objective

1. Introduce the theoretical concepts, terminology, conventions, principles, fundamental laws and methodologies for calculation of heat transfer by conduction, convection and radiation.

2. It is intended to impart basic knowledge to serve as a starting point for master subjects dealing with the modeling of heat transfer phenomena with generation and / or accumulation present in industry and the design of industrial equipment.

Specific objectives

1. The student must know how to determine and reduce his case, the heat losses of any non-isothermal system (pipes, walls, fins, etc.) using analytical or numerical solutions.

2. Bases of heat exchangers: know how to determine the exchange of thermal power between two fluids in motion at different temperatures (internal flow in ducts)

3. Know how to calculate a spectral balance of thermal radiant power between the surfaces of an enclosure (oven) with a non-participating medium (dry air or vacuum). Greenhouse effect.

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours large group</td>
<td>55,0</td>
<td>36.67</td>
</tr>
<tr>
<td>Self study</td>
<td>90,0</td>
<td>60.00</td>
</tr>
<tr>
<td>Hours small group</td>
<td>5,0</td>
<td>3.33</td>
</tr>
</tbody>
</table>

Total learning time: 150 h

CONTENTS

INTRODUCTION

Description:

Full-or-part-time: 15h
Theory classes: 6h
Self study: 9h
### UNIDIMENSIONAL CONDUCTION IN STATIONARY STATE

**Description:**

**Full-or-part-time:** 30h  
Theory classes: 12h  
Self study: 18h

### NUMERICAL METHODS (STATIONARY AND TRANSITORY STATE)

**Description:**

**Full-or-part-time:** 35h  
Theory classes: 14h  
Self study: 21h

### CONVECTION

**Description:**

**Full-or-part-time:** 22h  
Theory classes: 9h  
Self study: 13h

### THERMAL RADIATION

**Description:**

**Full-or-part-time:** 35h  
Theory classes: 14h  
Self study: 21h
GRADING SYSTEM

The four notes are used:

1) Final exam note (NE_F) is the mark of the joint test that will be made on the date fixed by the school.
2) Note partial exam (NE_P) is the note of the partial test that will be made in the middle of the quarter on the date set by the School.
3) Laboratory note (N_LAB) corresponds to the note of the laboratory practices and will be obtained from the report that the students deliver.
4) Note of numerical methods exam, (NE_NUM) approximately TWO WEEKS AFTER the partial test, an individual test of the subject of numerical methods will be carried out. The date varies according to the calendar and will be set at the beginning of the semester. The date and time of this test will be published in Athena.
5) Numerical simulation work with ANSYS (N_PNUM) we will also expose some example of numerical simulation solved in ANSYS and we will explain (2h) how the different boundary conditions are applied with this program, the latest version for students (32500 nodes). Organized with groups of 4 students maximum, a complex geometry exercise will be proposed, which will be solved with this advanced numerical simulation tool.

The final note of the final subject N_FINAL (rounded according to current regulations) is:

\[
N_{\text{FINAL}} = 0.55 \cdot \text{NE}_F + 0.20 \cdot \text{NE}_P + 0.10 \cdot \text{NE}_\text{NUM} + 0.10 \cdot \text{N}_\text{PNUM} + 0.05 \cdot \text{N}_\text{LAB}
\]

Exercises performed at home on the proposal of teachers (deliveries/tasks) are voluntary and can be requested at any time during the course. Only students who pass the subject will receive a mark increase that is marked between 0 and 1 points depending on the quality and quantity of the exercises delivered.

With the only objective of improving the grade, the faculty reserves the possibility of incorporating other elements or evaluation criteria in their case.

REASSESSMENT OF THE SUBJECT

The final grade of the subject in the reevaluation (N_FINAL_RE) is directly the grade obtained in the reevaluation examination (N_EF_RE), which replaces all previous notes.

CONVALIDATIONS

The note of numerical methods and / or laboratory practice are automatically validated (must have it approved in a previous call). Repeating students who want to improve this grade can repeat them again (without the risk of failing).

EXAMINATION RULES.

Final exam: focused on topics 4 and 5, it will consist of a test with conceptual questions and / or short calculation exercises (about the whole syllabus) and a couple of open problems. Total duration of the exam: 3 hours.

Mid-term exam: will include conceptual questions and / or calculation exercises. Its content will refer to the course topics 1 and 2.

An experimental laboratory practice is scheduled. The student must read in advance the text of the experiment that he will find in the digital campus and must deliver the corresponding report at the end of the practice session.

The re-take exam includes the entire syllabus and the lab content. Approximate duration 3-4 h. The re-take exams are similar to those carried out throughout the course.

During the completion of any of the exams, students will only be able to bring a programmable calculator and a printed sheet with the specific form of that test, which is on the digital campus.

BIBLIOGRAPHY

Basic:

Complementary: