Universidad del País Vasco Euskal Herriko Unibertsitatea

COURSE GUIDE 2025/26

Faculty 345 - Faculty of Engineering - Bilbao **Cycle** .

Degree GITECI30 - Bachelor`s Degree in Industrial Technology Engineering **Year** Third year

COURSE

27319 - Thermotechnics **Credits, ECTS:** 6

COURSE DESCRIPTION

In engineering practice, an understanding of the mechanisms of heat transfer is becoming increasingly important since heat transfer plays a crucial role in the design of vehicles, power plants, refrigerators, electronic devices, buildings, and bridges, among other things

We already use the principles of heat transfer when seeking thermal comfort. We insulate our bodies by putting on heavy coats in winter, and we minimize heat gain by radiation by staying in shady places in summer. We speed up the cooling of hot food by blowing on it and keep warm in cold weather by cuddling up and thus minimizing the exposed surface area. That is, we already use heat transfer whether we realize it or not.

In the THERMOTECHNICS subject fundamental knowledge of heat and mass transfer is developed this being a basic science that studies the velocity of the thermal energy transfer.

For this subject, we start from the idea that students have appropriate calculation bases (1st year Calculation and Advanced Mathematics 2nd year) and physical (Physics and Advanced of Physics 1st year). Also, it is desirable to have passed Thermodynamics, Fluid Mechanics and Differential Equations (all of them in the 2nd year), although the concepts pertaining to these issues are presented and reviewed as they are needed.

The above subjects are the main basis for the pre-intensification "Energy Technologies". If students are comfortable with all of these issues they are encouraged to choose this pre-intensification, which in turn is the basis for specialty Thermo-Energy Engineering Master.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

According to the verified memory of the Degree in Industrial Technology, the subject of Thermotechnics is part of the Specific Technologies module (M03). The specific competence to be developed in this subject and the expected module Learning Outcomes are as follows:

M03E1: Applied knowledge of thermal engineering.

LO1: Understanding of real problems in the Industrial Engineering environment, in any of its specialities. In addition, it is considered of special relevance that they are able to understand the importance of such a problem or failure on the industrial environment, so that they are able to make consequent decisions and do not have to regret human, environmental and/or economic losses.

LO2: Structured resolution of multidisciplinary problems in the industrial field. To this end, they are expected to design and implement industrial facilities or production and control processes.

Theoretical and Practical Contents

The THERMOTHECNICS subject is designed on this book: ÇENGEL, Y. A. HEAT AND MASS TRANSFER, A Practical Approach. McGraw-Hill. 3rd Edition 2007. The subject can be divided in three big sections, depending on the mechanism of heat transfer: conduction, convection and radiation. A fourth section may be added, an introduction to mass transfer.

CONTENTS:

CHAPTER 1.- INTRODUCTION AND BASIC CONCEPTS
CHAPTER 2.- HEAT CONDUCTION EQUATION
CHAPTER 3.- STEADY HEAT CONDUCTION
CHAPTER 4.- TRANSIENT HEAT CONDUCTION
CHAPTER 5.- NUMERICAL METHODS IN HEAT CONDUCTION
CHAPTER 6.- FUNDAMENTALS OF CONVECTION
CHAPTER 7.- EXTERNAL FORCED CONVECTION
CHAPTER 8.- INTERNAL FORCED CONVECTION
CHAPTER 9.- NATURAL CONVECTION
CHAPTER 10.- BOILING AND CONDENSATION
CHAPTER 11.- HEAT EXCHANGERS
CHAPTER 12.- FUNDAMENTALS OF THERMAL RADIATION

CHAPTER 13.- RADIATION HEAT TRANSFER
CHAPTER 14.- MASS TRANSFER

TEACHING METHODS

During the Lectures (M) a PowerPoint will be exposed every week, in order to explain the theory of each of the chapters. To assimilate the theory, during the GAs 2-3 exercises will be made, either by the lecturer or by one student on the board, or even working in small groups.
The student must show that he or she has achieved the intended learning outcomes, through the next tasks:

TASK 1: In each subject some concept or test questions are proposed so that the student fix the basic concepts of the subject. The answers are uploaded at eGELA.
TASK 2: In each subject 2-3 exercises are proposed so that the student works individually or in group and enlarges the collection of solved problems. The solutions are given.
TASK 3: 3 practices are performed at the laboratory (one for each of the mechanisms of heat transfer). In groups of 2-3 persons, they must take some measurements in order to make the calculations and and so subsequently deliver the report.

- GL1: Measure the thermal conductivity (conduction).
- GL2: Measure and calculate the convection coefficient (convection).
- GL3: Measure the emissivity (radiation).

TASK 4: 7 computer classes will be done (1.5 h each one) using the ESS software to solve different problems previously worked during the class. During the first hour of each class the teacher will lead some exercises and in the last half hour the student will have to solve a problem by his own, which will be evaluated. That software enables to do easily parametric and design calculations.

- GO1: Fundamentals of EES software and problems for chapters 3 and 4. (This one will not be evaluated).
- GO2: Problems for CHAPTER 5.
- GO3: Problems for CHAPTER 5.
- GO4: Problems for CHAPTER 5.
- GO5: Problems for CHAPTERS 6, 7 and 8.
- GO6: Problems for CHAPTERS 8, 9, 10 and 11.
- GO7: Problems for CHAPTERS 12 and 13.

TASK 5: In groups of 2-3 persons, a speech will be made using a Power Point presentation (or similar), about a topic related to heat transfer.
TASK 6: To solve exercises from previous years. The lecturer will upload at eGELA the statements and their solutions. Some of those exercises will be done at the classroom.
TASK 7: To do the 3 exercises proposed, related to heat and mass transfer, in the written exam individually.
TASK 8: To fill a rubric to evaluate the work developed by the classmates in the GL and S.

TYPES OF TEACHING

Types of teaching	M	S	GA	GL	GO	GCL	TA	TI	GCA
Hours of face-to-face teaching	22,5	1,5	22,5	3	10,5				
Horas de Actividad No Presencial del Alumno/a	33,75	2,25	33,75	4,5	15,75				

Legend:
M: Lecture-based — S: Seminar — GA: Applied classroom-based groups
GL: Applied laboratory-based groups — GO: Applied computer-based groups — GCL: Applied clinical-based groups
TA: Workshop — TI: Industrial workshop — GCA: Applied fieldwork groups

Evaluation methods

- End-of-course evaluation

Evaluation tools and percentages of final mark

- Written test, open questions 55%
- Exercises, cases or problem sets 30%
- Oral presentation of assigned tasks, Reading¿ 15%

ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

The evaluation system is continuous, 45% of the final grade comes from the laboratory practice, computer practice and seminar (GL+GO+S).

FINAL GRADE:

WRITTEN TEST (55% - They are 3 problems and it’s evaluated through geometric mean)
COMPUTER PRACTICE (6 GO x 2,5% = 15%)
LABORATORY PRACTICE (3 GL x 5% =15%)

SEMINAR (15%)

TERMS:

- MINIMUM REQUIREMENT: To pass the subject in the written exam a minimum of 40% must be obtained. Otherwise the proceedings will show the grade of the written test.
- GL+GO+S PRACTICES: Any student who has taken the course in the previous academic year and wishes to keep the practices grade (GL+GO+S) must inform the course coordinator before the start of the practices in the current academic year (week 4). In the event of opting for this choice, the previous year practice grade will be taken into account for the qualification of the ordinary and extraordinary call. If the student do not want to save the grade or do not communicate it within the deadline, the unique option will be the continuous assessment or the final assessment.
- HOLIDAYS: If because of holiday days any evaluable practice is not carried out, the total percentage on the final grade will be the same. This means that the value of the ones carried out will be adjusted in order to maintain the total percentage value.
- RUBRIC: Students who do not deliver the rubric to evaluate the team work, will receive a penalty of 0.5 points. There will be also a penalty in the group grade based on the score obtained in this rubric:
  · (S)he will not be penalized if (s)he gets more than 5.0.
  · (S)he will be substracted 0.5 points if (s)he gets between 3 and 5 (both included).
  · (S)he will be substracted 1 point if (s)he gets less than 3.
- RESIGN: The renunciation will suppose the qualification of not presented. To resign it will be enough just not to attend the written test.
- FINAL EVALUATION: The person who wishes to use the final evaluation system, thus resigning the continuous evaluation system, must notify by writing to the coordinator of the subject before 9 weeks have elapsed since the beginning of the semester. For that system the written exam is the same as for the ordinary call, maintaining the minimum requirement, but the student must pass an exam about one laboratory practice (15% of the total grade), two computer practices (15% of the total grade) and an oral presentation on a topic related to heat transfer (15% of the total grade).

EVALUATION CRITERIA:

WRITTEN EXAM:
- Identify the mechanisms for heat transfer
- Apply the basic concepts
- Write properly the formulae
- Mathematical developments and get results
- Critical evaluation of the results

COMPUTER PRACTICES:
- Knowledge of EES
- Apply basic concepts of heat transfer and finite differences
- Identify and correct the errors made through the programming task

REPORTS FROM LABORATORY PRACTICES:
- Take right measures at the laboratory
- Apply properly the formulae
- Delivery and formats

PRESENTATIONS OF SEMINARS:
- Format and time of the presentation
- Contents of the presentation
- Oral exposure of the presentation

TEAM WORK:
- Engagement in the team work
- Positive attitude
- Attendance and punctuality to meetings

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

The evaluation system is continuous, 45% of the final grade comes from the laboratory practice, computer practice and seminar (GL+GO+S).

FINAL GRADE:

WRITTEN TEST (55% - They are 3 problems and it’s evaluated through geometric mean)
COMPUTER PRACTICE (15%)

LABORATORY PRACTICE (15%)
SEMINAR (15%)

In order to get the final grade, in the case of fulfilling the minimum requirement, the grades of the GL+GO+S obtained during the course must be added. Thus, the grades of GL+GO+S obtained before the ordinary call will be kept during the course.

TERMS:

- MINIMUM REQUIREMENT: To pass the subject in the written exam a minimum of 40% must be obtained. Otherwise the proceedings will show the grade of the written test.
- NEGATIVE GRADES IN GL+GO+S: In the event that a student had not passed the part of GL+GO+S (less than 50% in the grade) and would like to repeat this part to be able to obtain 100% of the qualification, the student must notify by writing to the coordinator of the subject at least one month before the written test. In such case the students will have the right to present themselves to the exams and activities of the final evaluation test.
- RESIGN: The renunciation will suppose the qualification of not presented. To resign it will be enough just not to attend the written test.
- FINAL EVALUATION: The person who wishes to use the final evaluation system, thus resigning the continuous evaluation system, must notify by writing to the coordinator of the subject at least one month before the written test. For that system the written test is the same as for the extraordinary call, maintaining the minimum requirement, but the student must pass an exam about one laboratory practice (15% of the total grade), two computer practices (15% of the total grade) and an oral presentation on a topic related to heat transfer (15% of the total grade).

MANDATORY MATERIALS

- Material through eGELA platform (power points, exercices, statements, reports...)
- ÇENGEL, Y. A. HEAT AND MASS TRANSFER, A Practical Approach. McGraw-Hill. 3rd Edition 2007.

BIBLIOGRAPHY

Basic bibliography

- INCROPERA, F. P. & DE WITT, D. P. Introduction to Heat Transfer. John Wiley & Sons. New York. 1990.
- Carnahan B., Luther H.A., Wilkes J.O., Cálculo numérico, métodos aplicaciones

Detailed bibliography

- CHAPMAN, A. J. Transmisión del Calor. Ed. Interciencia. Madrid. 1974.
- KREITH, F. & BOHN, M. Principios de transferencia de Calor. Thomson. Madrid. 2002.
- Ishachenko V., Osipova V., Sukomel A.,Transmisión del calor
- ASHRAE. Handbook of Fundamentals.
- ASHRAE. Handbook of System and Applications
- Eckert, E.R.G., Drake, R.M.- Análisis of Heat and Mass Transfer. Mc Graw-Hill. (1.972).
- Hotel, H.C., Sarofim, A.F.- Radiative Transfer. Mc Graw-Hill Company (1.976).
- Jacob, M.- Heat Transfer, Vol. I y II. JohnWiley and Sons. (1.957).
- Kays, W.m., London, A.L.- Compact Heat Exchangers. Mc Graw-Hill. (1.964).

Journals

- Heat Transfer Engineering. USA.
- International Journal of Heat and Mass Transfer, Elsevier.
- Applied Thermal Engineering, Elsevier.
- ASHRAE Journal. USA.
- Energy, Pergamon.

Web sites of interest

- http://www.ashrae.org/

OBSERVATIONS

The methodology proposed in this guide may undergo slight changes because in some chapters the new "flipped room" learning methodology may be implemented. The main change in this case is that the master classes are taught by means of videos and during those hours of class, quiz questionnaires and guided problems will be carried out.