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**	Second year

COURSE

27312 - Thermodynamics	**Credits, ECTS:**	6

COURSE DESCRIPTION

The subject focuses on fundamental concepts related to the basic principles of thermodynamics and heat transfer required for the Industrial Technology Engineering degree (Grado en Ingeniería en Tecnología Industrial). The first and second laws of thermodynamics for closed systems and for control volumes are studied. Thermodynamic relations derived from them are also studied. Furthermore, the properties of pure substances and thermodynamic models of industrial interest are analyzed. The concepts of entropy and exergy are also introduced.

This is a second course compulsory subject, which covers the basic principles and their application to solving engineering problems related to applied thermodynamics and heat transfer.

The subject is vertically coordinated with the third course subject 'Heat Transfer' (Named 'Termotecnia' in Spanish). Both subjects constitute the base for the degree Pre Intensification ENERGY TECHNOLOGIES and for the Master speciality THERMAL ENERGY ENGINEERING.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

The subject of THERMODYNAMICS is included within the Common Module of the Industrial Branch (M02 Rama industrial) in the Degree of Industrial Technology Engineering (Grado en Ingeniería en Tecnología Industrial). The specific competence corresponding to the subject is:

- M02R1: Knowledge of applied thermodynamics and heat transfer. Basic principles and their application for solving engineering problems.

This specific competence has two associated degree competences:

- G003: Knowledge in basic and technological subjects that will enable students to learn new methods and theories. This way, students will be able to adapt to new situations with versatility. (Specific competence)

- G004: Ability to solve problems with initiative, decision making, creativity, critical thinking and to communicate and transmit knowledge, skills and abilities in the field of Industrial Engineering. (Transversal competence)

Theoretical and Practical Contents

The structure of the subject of THERMODYNAMICS is based on the first SEVEN chapters of the book M.J. Moran, H.N. Shapiro, FUNDAMENTALS OF ENGINEERING THERMODYNAMICS, distributed along 15 weeks, as follows:

CHAPTER 1 - GETTING STARTED: INTRODUCTORY CONCEPTS AND DEFINITIONS (Week 1)
1.1 Using Thermodynamics
1.2 Defining Systems
1.3 Describing Systems and Their Behavior
1.4 Measuring Mass, Length, Time, and Force
1.5 Two Measurable Properties: Specific Volume and Pressure
1.6 Measuring Temperature
1.7 Engineering Design and Analysis

CHAPTER 2 - ENERGY AND THE FIRST LAW OF THERMODYNAMICS (Weeks 2 to 3)
2.1 Reviewing Mechanical Concepts of Energy
2.2 Broadening Our Understanding of Work
2.3 Broadening Our Understanding of Energy
2.4 Energy Transfer by Heat
2.5 Energy Accounting: Energy Balance for Closed Systems
2.6 Energy Analysis of Cycles

CHAPTER 3 - EVALUATING PROPERTIES (Weeks 4 to 6)
3.1 Fixing the State
EVALUATING PROPERTIES: GENERAL CONSIDERATIONS
3.2 p-v-T Relation
3.3 Retrieving Thermodynamic Properties

3.4 Generalized Compressibility Chart
EVALUATING PROPERTIES USING THE IDEAL GAS MODEL
3.5 Ideal Gas Model
3.6 Internal Energy, Enthalpy, and Specific Heats of Ideal Gases
3.7 Evaluating u and h using Ideal Gas Tables, Software, and Constant Specific Heats
3.8 Polytropic Process of an Ideal Gas

CHAPTER 4 - CONTROL VOLUME ANALYSIS USING ENERGY (Weeks 7 to 8)
4.1 Conservation of Mass for a Control Volume
4.2 Conservation of Energy for a Control Volume
4.3 Analyzing Control Volumes at Steady State
4.4 Transient Analysis

CHAPTER 5 - THE SECOND LAW OF THERMODYNAMICS (Week 9)
5.1 Introducing the Second Law
5.2 Identifying Irreversibilities
5.3 Applying the Second Law to Thermodynamic Cycles
5.4 Defining the Kelvin Temperature Scale
5.5 Maximum Performance Measures for Cycles Operating Between Two Reservoirs
5.6 Carnot Cycle

CHAPTER 6 - USING ENTROPY (Weeks 10 to 12)
6.1 Introducing Entropy
6.2 Defining Entropy Change
6.3 Retrieving Entropy Data
6.4 Entropy Change in Internally Reversible Processes
6.5 Entropy Balance for Closed Systems
6.6 Entropy Rate Balance for Control Volumes
6.7 Isentropic Processes
6.8 Isentropic Efficiencies of Turbines, Nozzles, Compressors, and Pumps
6.9 Heat Transfer and Work in Internally Reversible, Steady-State Flow Processes

CHAPTER 7 - EXERGY ANALYSIS (Weeks 13 to 15)
7.1 Introducing Exergy
7.2 Defining Exergy
7.3 Closed System Exergy Balance
7.4 Flow Exergy
7.5 Exergy Rate Balance for Control Volumes
7.6 Exergetic (Second Law) Efficiency

TEACHING METHODS

THEORY (M) AND CLASSROOM PRACTICAL SESSIONS (GA)

During the theory sessions (M) the lecturer explains the theoretical content of each of the chapters to the students. In order to help to assimilate the theoretical content, during the classroom practical sessions (GA) several exercises will be performed, which might be solved by the lecturer, some student, or even working in small groups.

Each chapter will have a related PowerPoint and a PDF document with a series of exercises to be performed during the GA and other exercises with solutions to be solved by the student. Yo facilitate the coordination between the various groups of the course, all the lecturers will use the same PowerPoints and exercise documents. Both documents for each chapter will be uploaded by the theory lecturer to the eGela platform in their corresponding language. The PowerPoint presentations will strictly follow the structure and content of the book M.J. Moran, H.N. Shapiro, Fundamentals of Engineering Thermodynamics (English fifth edition) so that it is easy for the student to relate the presentation slides with the different sections of the book.

LABORATORY PRACTICES (GL)

The laboratory practices (GL) will consist of 4 sessions throughout the course. The corresponding practice scripts can be found in the virtual platform eGela. Each student will do a multiple choice test before going to the lab and perform data collection. These tests will be instantaneously marked by means of the eGela platform. Finally, students must submit a report by groups (usually 4 students per group), with the results and conclusions of each laboratory practice.

The scripts of each practice will be uploaded by the laboratory practice lecturer to the eGela platform in their corresponding language. The laboratory practice lecturer will correct and publish in eGela the grades of each report before the deadline for submission of the report of the next laboratory practice.

The students will fill a rubric to evaluate the work developed by the classmates in the GL.

SOLVING EXERCISES (TERMOGRAF)

The third type of task to be performed by the students is the resolution of 5 thermodynamic problem deliveries by using the TERMOGRAF software. The problem statements are arranged in the eGela platform and each student must solve and deliver them individually within 1 week via the eGela virtual platform. The statements will be uploaded by the theory lecturer to the eGela platform in its corresponding language. The theory lecturer will correct and publish the grades of each delivery before the deadline of the next TERMOGRAF delivery.

THERMODYNAMICS PROGRAM

WEEK	THEORY AND CLASSROOM PRACTICAL	LABORATORY PRACTICES	TERMOGRAF DELIVERIES
Week 1	CHAPTER 1 (3.5 hours)		
Week 2	CHAPTER 2 (3.5 hours)		
Week 3	CHAPTER 2 (3.5 hours)		
Week 4	CHAPTER 3 (3.5 hours)	LAB 1 (2 hours)	
Week 5	CHAPTER 3 (3.5 hours)	LAB 1 (2 hours)	TERMOGRAF 1
Week 6	CHAPTER 3 (3.5 hours)		
Week 7	CHAPTER 4 (3.5 hours)	LAB 2 (1.5 hours)	TERMOGRAF 2
Week 8	CHAPTER 4 (3.5 hours)	LAB 2 (1.5 hours)	
Week 9	CHAPTER 5 (3.5 hours)		
Week 10	CHAPTER 6 (3.5 hours)	LAB 3 (2 hours)	
Week 11	CHAPTER 6 (3.5 hours)	LAB 3 (2 hours)	TERMOGRAF 3
Week 12	CHAPTER 6 (3.5 hours)	LAB 4 (2 hours)	
Week 13	CHAPTER 7 (3.5 hours)	LAB 4 (2 hours)	TERMOGRAF 4
Week 14	CHAPTER 7 (3.5 hours)		TERMOGRAF 5
Week 15	CHAPTER 7 (3.5 hours)		

TYPES OF TEACHING

Types of teaching	M	S	GA	GL	GO	GCL	TA	TI	GCA
Hours of face-to-face teaching	37,5		15	7,5					
Horas de Actividad No Presencial del Alumno/a	56,25		22,5	11,25					

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

- Continuous evaluation
- End-of-course evaluation

Evaluation tools and percentages of final mark

- Written test, open questions 65%
- Exercises, cases or problem sets 15%
- Teamwork assignments (problem solving, Project design) 20%

ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

WRITTEN EXAM: The written exam consisting on theory and problems will account for 65% of the final grade. The examination shall consist of:

- Problem 1 (about 40 points)
- Problem 2 (about 40 points)
- Theory (about 20 points)

Therefore, the 100 points of the written exam represent 65% of the final grade.

LABORATORY PRACTICES (GL): The four laboratory practices account for 20% of the final grade. Each of the four reports will be evaluated over 10 points and the weight of each of these reports in the final grade will be 3%. Each of the four tests will be evaluated over 10 points and the weight of each of these tests in the final grade will be 2%. Each test is composed of 10 questions related to the script of the practice and the subject theory classes.

SOLVING EXERCISES (TERMOGRAF): these exercises are assessed continuously with various exercises (done with the TERMOGRAF software) throughout the course and its maximum value is 15% of the final grade. Each TERMOGRAF delivery will have 30 questions so that at the end of the five deliveries the student will have answered 150 questions. Each correct question corresponds to 0.1% of the final grade.

FINAL GRADE:

WRITTEN EXAM (65%) + LABORATORY PRACTICES (20%) + SOLVING EXERCISES (TERMOGRAF) (15%)

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.

IMPORTANT:

- To pass the subject, a minimum of 40% must be obtained in the written exam. The proceedings will show the written exam grade in case this minimum is not obtained.

- To resign this call it will be enough just not to attend the written exam.

- If any of the laboratory practices matches with a public holiday, it won't be carried out. The value of the other practices will be adjusted in order to maintain the total percentage of the laboratory practices in the final score.

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

MANDATORY FOR STUDENTS WHO HAVE PASSED GL + TERMOGRAF DURING THE COURSE:

The extraordinary call consists only of the WRITTEN EXAM (65% of the final grade).

The grades of the LABORATORY PRACTICES and TERMOGRAF will be valid for the extraordinary call. Therefore, for the final grade calculation, the grades obtained during the course on the LABORATORY PRACTICES (GL) (20%) and SOLVING EXERCISES (TERMOGRAF) (15%) will be added to that obtained in the WRITTEN EXAM under the same conditions as in the ordinary call.

OPTIONAL FOR STUDENTS WHO HAVE NOT PASSED GL + TERMOGRAF DURING THE COURSE:

The extraordinary call will consist on performing:

- The same written exam as the other students (65%).
- Deliver prior the written exam five NEW TERMOGRAF deliverables. Students must request for the statements of these new deliverables to the coordinator at least one week before the extraordinary call date (15%).
- Conduct four NEW TESTS about the four laboratory practices and pass an exam about a randomly selected laboratory practice (20%).

IMPORTANT:

- For all students: to pass the subject in the written exam a minimum of 40% must be obtained. The proceedings will show the written exam grade in case this minimum is not obtained.

- It is considered GL + TERMOGRAF passed if the student gets 50% or more of the maximum possible points of adding both grades.

- If GL + TERMOGRAF is not passed and if the student does not request the statements of five new TERMOGRAF deliverables, they will be assessed as the students who have passed GL + TERMOGRAF.

- To resign this call it will be enough just not to attend the written exam.

MANDATORY MATERIALS

Materials published during the course on the virtual platform eGela: Theory class presentations, exercise statements, Thermodynamic tables and diagrams, practice scripts, reports, etc.).

BIBLIOGRAPHY

Basic bibliography

- M. J. Moran H.N. Shapiro, Fundamentals of Engineering Thermodynamics, any edition, Wiley.

Detailed bibliography

-Y.A. Cengel, M.A. Boles; Termodinámica, Mc. Graw Hill, 2.011.

-J.M. Sala, F. Jiménez; Termodinámica, Servicio Publicaciones E.T.S.I.I. De Bilbao, 1.996

-J.M. Sala, L. López, F. Jiménez, V De La Peña, J.J. Eguia; Ampliación Termodinámica, Servicio De Publicaciones De La E.T.S.I.I. De Bilbao, 1.998.

-R. Wark; Termodinámica, Mc. Graw-Hill, 1.984.

-C. Mataix; Termodinámica Técnica Y Máquinas Térmicas, Ed. Ecaci.

Journals

Web sites of interest

OBSERVATIONS

1.- The LABORATORY PRACTICE grades obtained in the continuous evaluation can be maintained, but only from the course when they were carried out to the next one. The TERMOGRAF grades will not be valid from one course to the next one.

2.- If anyone wants to apply for the final evaluation assessment system, they must notify it to the coordinator of the subject, at least, one month before the written exam.

The final written test will consist of carrying out:

- The same written exam as the other students (65%).
- Deliver before the written exam the same TERMOGRAF deliverables as the other students (15%).
- Perform the same four laboratory practice tests as the other students and pass an exam about a randomly selected laboratory practice (20%).