ANEXO I

Escuela Técnica Superior de Ingeniería

GENERAL SPECIFICATIONS

BACHELOR IN ELECTRICAL ENGINEERING
Course 23/24

Subject Data

Name:	
Engineering Thermodynamics	
English name:	
Engineering Thermodynamics	
Code:	**Type:**
606310203, 609417203	Compulsory

Hours:			
	Total	**In class**	**Out class**
Time distribution	150	60	90

ECTS:				
Standard group	**Small groups**			
	Classroom	**Lab**	**Practices**	**Computer classroom**

Departments:	**Knowledge areas:**
Ingeniería Eléctrica y Térmica, de Diseño y Proyectos	Máquinas y Motores Térmicos
Year:	**Semester**
2°	1°

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TEACHING STAFF		
Name:	**E-mail:**	**Telephone**
Domingo Borrero Govantes	domingo.borrero@die.uhu.es	666 20 25 00
Others Data (Tutoring, schedule...)		

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SPECIFIC INFORMATION OF THE COURSE

1. Contents description:

1.1 In English:

Introduction to thermodynamics.
Laws of thermodynamics.
Thermodynamic properties of pure substances.
Energy and mass balances in open systems.
Heat engines.
Steam cycles.
Gas cycles.
Refrigeration cycles.

1.2 In Spanish:

Introducción a la Termodinámica.
Principios de la Termodinámica.
Propiedades de las Sustancias Puras.
Balances de Materia y Energía en sistemas abiertos.
Máquinas Térmicas.
Ciclos de potencia de vapor.
Ciclos de potencia de gas.
Ciclos de refrigeración.

2. Background:

2.1 Situation within the Degree:

Thermodynamics develops basic concepts needed for the training of an electrical engineer.

In that sense, the subject is essential for the graduates with a solid theoretical base and experimental, whose analytical, design and laboratory experiences make them attractive to the industry.

The knowledge acquired is useful in the study of subjects such as power plants, automotive, heat and cold, environmental engineering, alternative sources of energy, etc.

2.2 Recommendations

It is recommended having passed Phisics and Maths.

3. Objectives (as result of teaching):

Understanding of the first law of thermodynamics and energy balance in Open and closed system.

Second principle of thermodynamics analysis and its application to the calculation of performances and efficiencies.

Understanding the basic processes of power and cooling cycles.

Analysis of the air conditioning processes.

4. Skills to be acquired

4.1 Specific Skills:

C01: Knowledge of applied thermodynamics and heat transmission. Basic principles and their application to solving engineering problems

C10: Basic knowledge and application of environmental technologies and sustainability

4.2 General, Basic or Transversal Skills:

CB5. Develop the learning skills required to undertake further studies with a high degree of autonomy.
G01: Problem-solving ability
G04: Ability to apply knowledge in practice
G07: Capacity for analysis and synthesis
G09: Creativity and inventive spirit in solving scientific and technical problems
G12: Capacity for autonomous and deep learning
G14: Ability to manage information in the solution of problematic situations
G16: Sensitivity for environmental issues
G17: Capacity for critical reasoning
CT2: Development of a critical attitude in relation to the capacity of analysis and synthesis.
CT3: Development of an attitude of inquiry that allows the revision and permanent advancement of knowledge.

5. Training Activities and Teaching Methods

5.1 Training Activities:

- Theory sessions on the contents of the Program.
- Problem-Solving Sessions.
- Practical sessions in specialized laboratories or computer rooms.
- Activities Academically Directed by the Faculty: seminars, conferences, development of works, debates, collective tutorials, evaluation activities and self-evaluation.

5.2 Teaching Methods::

- Participatory Master Class.
- Development of Practices in Specialized Laboratories or Computer Classrooms in small groups.
- Problem Solving and Practical Exercises.
- Individual or Collective Tutorials Direct interaction between teachers and students.
- Approach, Realization, Tutoring and Presentation of Works.
- Evaluations and Exams 5.3. Development and Justification:

5.3 Development and Justification:

In theory sessions the basic concepts of each subject will be developed. These sessions will last 45 minutes more or less. The rest of the class will be solving problems, dedicating the rest (duration approximately 45 minutes). Depending on the subject, the one and a half hour slot assigned to this subject may be devote entirely to develop a theory topic or to make a session of problems. Laboratory practices will last 5 sessions. Each session involves a work in the laboratory of approximately 1.5 hours, work It will be held in small groups (4-5 students per group). A report on the laboratory work done. In addition, 7.5 hours are included to to deep in the problem analysis.

6. Detailed Contents

1. INTRODUCTION.
1.1. Introduction.
1.2. System, Properties, State and Equilibrium.
1.3. Thermodynamic Processes.
1.4. Fundamental Properties.
1.5. Zeroth Law of Thermodynamics: Temperature.

2. FIRST LAW OF THERMODYNAMICS.
2.1. Introduction.
2.2. Energy Transfer by Work.
2.3. The First Law of Thermodynamics: Internal Energy.
2.4. Energy Transfer by Heat.
2.5. Energy Balance for Closed Systems.
2.6. Energy Analysis of Steady-Flow Systems.

3. PROPERTIES OF PURE SUBSTANCES.
3.1. State Postulate.
3.2. Phase-Change Processes
3.3. Thermodynamic Diagrams for Phase-Change Processes
3.4. Property Tables.
3.5. Specific Heat.
3.6. Incompressible Substance Model.
3.7. Ideal Gas Model.

4. SECOND LAW OF THERMODYNAMICS.
4.1. Introduction.
4.2. Thermal Energy Reservoirs. Heat Engines, Refrigerators and Heat Pumps.
4.3. Statements for the Second Law.
4.4. Reversible and Irreversible Processes.
4.5. Second Law Corollaries. Absolute Temperature Scale.

5. ENTROPY.
5.1. Clausius Inequality.
5.2. Entropy.
5.3. The Increase of Entropy Principle.
5.4. Entropy Balance.
5.5. Determination of the Entropy Change.
5.6. Thermodynamic Diagrams Including Entropy.
5.7. Isentropic Processes. Isentropic Efficiciency.
5.8. Reversible Steady-Flow Processes.

6. STEAM POWER CYCLES.
6.1. Introduction
6.2. The Carnot Vapor Cycle.
6.3. Rankine Cycle.
6.4. Efficiency increase of a Rankine Cycle.
6.5. Internal Reheat.
6.6. Regeneration.
6.7. Cogeneration.

7. GAS POWER CYCLES.
7.1. Introduction.
7.2. Air-Standard Assumptions.
7.3. The Otto Cycle.
7.4. The Diesel Cycle.
7.5. The Dual Cycle.
7.6. Gas Turbine Cycle: The Brayton Cycle.
7.7. The Brayton Cycle with regeneration.
7.8. Ideal Jet-Propulsion Cycles.
7.9. Modifications to Turbojet Engines.

8. REFRIGERATION AND HEAT PUMP SYSTEMS.
8.1. Introduction.
8.2. The Reversed Carnot Cycle.
8.3. Vapor-Compression Refrigeration.
8.4. Refrigerant Properties.
8.5. Heat Pumps.
8.6. Gas Refrigeration Cycles.

9. IDEAL GAS MIXTURES AND PSYCHROMETRIC APPLICATIONS.
9.1. Non-Reactive Mixtures of Ideal Gases.
9.2. Thermodynamic Properties of Humid Air.
9.3. Adiabatic Saturation. Wet-Bulb Temperatures.
9.4. Psychrometric Chart.
9.5. Air-Conditioning Processes.

7. Bibliography

7.1 Basic Bibliography:

- Thermodynamics. K. Wark and D.E. Richards (McGraw-Hill, 6th ed., 2000).

- Fundamentals of Engineering Thermodynamics, M.J. Moran and H.N. Shapiro (John Wiley and sons, 6th ed., 2008).

- Engineering Thermodynamics, J.B. Jones and R.E. Dugan (Prentice Hall, 1997).

- Thermodynamics. . An Engineering Approach. Y.A. Çengel and M.A. Boles (McGraw-Hill, 6th ed., 2008).

7.2 Additional Bibliography:

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8. Systems and Assessment Criteria

8.1 System for Assessment:

- Theory and problems Exam
- Lab defense report
- Software programm Cyclepad exercises
- Individual Student Monitoring

8.2 Assessment Criteria and Marks:

8.2.1 Examinations Convocatory I

Traditional assessment (CONTINUOUS ASSESSMENT)

In order to assess student learning and their level of acquisition of skills, this subject will follow a semi-continuous evaluation system. The student's overall grade will be established based on the result obtained in each of the evaluation tests (mandatory and/or voluntary) that will be carried out throughout the semester. The tests to be carried out will be the following:

- Attendance at laboratory practices, carrying out tests, and elaboration of a memory of experimental results (MANDATORY). The practices will take place in the ETSI Thermal Engines and Machines laboratory. Attendance will be compulsory. Students must come having read and understood the practice script. The execution of the essays and the subsequent writing of the reports will be carried out in groups of 3-5 students. In the student's attitude during the laboratory sessions, and in the content of the reports, the acquisition of the CB5, G04, G07, G14, G16, G17, CT2 and CT3 skills will be evaluated. It will be a requirement to pass the subject that the practice mark is equal to or greater than 3 out of 10.

- A comprehensive written examination of theory and problems. In this exam, all the contents taught in the subject will be asked. It will consist of a series of theoretical questions and problems where the skills C01, C10, CB5, G01, G04, G07, G09, G12, G17, CT2 and CT3 will be evaluated. It will be a requirement to pass the course that the overall exam grade is equal to or greater than 4.5 out of 10.

- A course work. At the discretion of the teacher, and depending on the progress of the course, this work may be VOLUNTARY or COMPULSORY. In case of being a VOLUNTEER, the work will require a minimum grade of 6 out of 10 to be taken into account in the overall grade, and its weight in it will be 10%. If it is MANDATORY, it will entail a defense and presentation in class, and its weight in the overall grade will be 30%.

QUALIFICATION

The weight of the exam grade in the overall grade will depend on whether or not the course work is compulsory. If the course work is imposed as compulsory (30%), then the weight of the exam grade in the overall grade will be 55%. If the course work is left as voluntary (10%), then the weight of the exam grade in the overall grade will be 75%.

The global qualification of the subject will be calculated by weighting the note of the different tests in the following way:

If the course work is imposed as compulsory, the overall grade will be calculated as:

- Overall grade = 0.15 × Internship grade + 0.30 × Compulsory work grade + 0.55 × Overall exam score

If the course work is left voluntary, the overall grade will be calculated as:

- Overall grade = 0.15 × Internship grade + 0.10 × Volunteer work grade + 0.75 × Overall Exam Score

In any case, it will be a requirement to pass the subject that the average global grade of all the tests is equal to or greater than 5, and that all the minimum grade requirements mentioned above have been met: >3 in the practices and >4.5 in the overall exam.

Students who carry out any type of activity (work, practice or exam) from the beginning of the course without having expressly stated their intention to take advantage of the Single Final Assessment will be considered by default to take Continuous Assessment and in no way may they be considered in the record as "Not presented".

All of the above is applicable to the first ordinary call for the course (February). In the rest of the calls, the student will be evaluated by means of a single global exam. It is left to the discretion of the teacher to keep the mark of any of the continuous assessment activities (especially practices) carried out during the school period.

8.2.2 Examinations Convocatory II

To assess student learning and their level of acquisition of skills in the second call (September), there will be a single evaluation test consisting of a global written exam of theory, problems and practices. In this exam, all the contents taught in the subject will be asked. It will be a requirement to pass the subject that the exam mark is equal to or greater than 5. It is left to the teacher's discretion to keep the mark of any of the continuous assessment activities (especially practices) carried out during the academic period for this call.

8.2.3 Examinations Convocatory III

To assess student learning and their level of acquisition of skills in the third call (December), there will be a single evaluation test consisting of a global written exam of theory, problems and practices. In this exam, all the contents taught in the subject will be asked. It will be a requirement to pass the subject that the exam mark is equal to or greater than 5. It is left to the teacher's discretion to keep the mark of any of the continuous assessment activities (especially practices) carried out during the academic period for this call.

8.2.4 Extraordinary Convocatory

To assess the learning of students and their level of acquisition of skills in the extraordinary call in November, there will be a single evaluation test consisting of a global written exam of theory, problems and practices. In this exam, all the contents taught in the subject will be asked. It will be a requirement to pass the subject that the exam mark is equal to or greater than 5. It is left to the teacher's discretion to keep the mark of any of the continuous assessment activities (especially practices) carried out during the academic period for this call.

8.3 Single Final Evaluation:

SINGLE FINAL EVALUATION

To benefit from the Single Final Assessment system, the student must notify the course coordinator by email within the first two weeks of its delivery, or within the two weeks following enrollment if this has occurred after the beginning of the subject. Outside the aforementioned deadlines, the student may only request the Single Final Evaluation for exceptional reasons (work reasons, illness or disability) that must be duly justified. For more information, you can consult the UHU Assessment Regulations of March 13, 2019 (article 8).

Students under this system will be evaluated in a single academic act through the following tests:

- Theory test 25%. It will consist of several theoretical questions to be reasonably resolved.
- Problem test 60%. It will consist of several problems to solve numerically.
- Practice test 15%. It will consist of various theoretical and numerical questions related to the experiences developed in the laboratory sessions.

In order to pass the subject, it will be a requirement that the average global grade of the three tests is equal to or greater than 5, and that a minimum grade of 3.5 out of 10 has been obtained in each of them.

Students who carry out any type of activity (work, practice or exam) from the beginning of the course without having expressly stated their intention to take advantage of the Single Final Assessment will be considered by default to take Continuous Assessment and in no way may they be considered in the record as "Not presented".