Bachelor in Electrical Engineering

Course information

Year 2019-20

GENERAL SPECIFICATIONS				
English name				
Engineering Thermodynamics				
Spanish name				
Termotecnia				
Code		**Type**		
606310203, 609417203		Compulsory		
Time distribution				

	Total	**In class**	**Out class**
Working hours	150	60	90

ECTS: 6

Standard group	**Small groups**			
	Classroom	**Lab**	**Practices**	**Computer classroom**
4.5		1.5	0	0

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

TEACHING STAFF			
Name	**E-Mail**	**Telephone**	**Office**
Domingo Borrero Govantes	domingo.borrero@die.uhu.es	666202500	340/ETSI/El Carmen
Gabriel López Rodríguez (coordinator)	Gabriel.lopez@die.uhu.es	959 217 582	345/ETSI/El Carmen

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 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:

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:

-

8. Systems and Assessment Criteria

8.1. System for Assessment:

- Theory and problems Exam
- Lab defense report

8.2. Assessment Criteria and Marks:

The evaluation of the student will be made based on the grade obtained in the written exam and in the memory of the Laboratory practices. There will be a single exam that will consist of theoretical issues and problems where they will be evaluated the competitions C01, C10, CB5, G01, G09, G12, G17 and T01.

In addition, students will have to perform the laboratory practices compulsorily and deliver a memory where CB5, G04, G07, G14 and G16 competences will be evaluated.

The final grade will be = 0.85 Exam mark + 0.15 Practice mark. To pass the subject the final grade must be equal to or greater than 5, and both must be greater than 4.

Students who take part in the final single evaluation must complete the following tests in a single academic act:

1.- 15% theory test. It will consist of several questions to be solved in a reasoned way based on the laws and concepts
2.- Problems 70%,.It will consist of several problems to solve numerically
3.- Practical test 15%. It will consist of several questions of both theoretical and numerical character related to the experiences developed in Lab.

In order to pass the subject, a minimum of 50% must be obtained in the joint theory and problems part and 50% in the Lab practical test.