Bachelor in Electrical Engineering

Course information

Year 2018-19

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	**0**	1.5	0	0
Departments		**Knowledge areas**		
Electrical and Thermal Engineering, Design and Projects		Heat Engines and Machines		
Year		**Semester**		
2º		1º		

TEACHING STAFF			
Name	**E-Mail**	**Telephone**	**Office**
Bosch Saldaña, Juan Luis	jlbosch@die.uhu.es	959217590	ALPB-28 *Aldebarán/La Rábida*

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:

The class on Engineering Thermodynamics explains concepts which are fundamental for an Electrical Engineer. In this regard, the class is essential for the training of bachelors with solid theoretical and experimental basis, and develops analytic thinking, with expertise in lab practices which makes them a coveted asset for the industry.
The acquired knowledge will be of major importance in different fields, like power production plants, automobile industry, air conditioning, environmental engineering, renewable energies, etc.

2.2. Recommendations:

It is recommended to have previous knowledge of first year of college level in Physics and Calculus.

3. Objectives (as result of teaching):

- Understand the first law of thermodynamics and perform energy balances in both close and open systems.
- Analyze the second law of thermodynamics and its application to the estimation of coefficients of performance and efficiencies.
- Understand the basic processes within the power production and refrigeration cycles.
- Analyze air conditioning processes.

4. Skills to be acquired

4.1. Specific Skills:

· C01: Knowledge about applied thermodynamics and heat transfer. Basic concepts and its application to engineering problems solving.
· C10: Basic knowledge and application of environmental technologies and sustainability

4.2. General Skills:

· CB5: Development of the learning abilities needed for graduate students with a high degree of self-sufficiency
· G01: Problem solving ability
· G04: Ability to apply knowledge to solve real-world problems
· G07: Ability to analyze and summarize
· G09: Creativity and inventive approach to problem solving in sciences and technologies
· G12: Ability to reach a deep and self-sufficient learning
· G14: Ability to manage information while solving difficult situations
· G16: Environmental topics awareness
· G17: Ability to think critically
· T01: Second-language acquisition

5. Training Activities and Teaching Methods

5.1. Training Activities:

- Theory sessions
- Problem solving sessions
- Lab practices in specialized laboratories
- Other activities like: seminars, conferences, project supervision, tutorials and assessments.

5.2. Teaching Methods:

- Participative master class
- Realization of lab practices in specialized laboratories
- Problem solving classes
- Individual and small group tutorials
- Proposal, development, guidance and presentation of essays
- Assessments and tests

5.3. Development and Justification:

The basic concepts of the topics studied in Engineering Thermodynamics will be introduced in the 1.5 hour sessions in the classroom, which will usually include 45 minutes of lectures and 45 minutes of problem solving and discussion. Depending on the subject some of these classes will be fully used for lecturing or problem solving. There will also be 5 laboratory practical sessions of 1.5 hours where small groups of 4 to 5 students will take measurements and perform experiments which illustrate the basic concepts explained in the classroom and the students will submit a lab report about the work done in the laboratory. Also, 5 sessions of 1.5 hours will be reserved for solving practical exercises in small groups to delve into 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.
3.4. Specific Heat.
3.6. In-compressible 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 Efficiency.
5.8. Reversible Steady-Flow Processes.
26. 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. Co-generation.
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 (MC GRAW-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 (MC GRAW-HILL , 6TH ED., 2008).

7.2. Additional Bibliography:

- Termodinámica Lógica y Motores Térmicos. J. Agüera Soriano (Ciencia 3, 1993).

8. Systems and Assessment Criteria

8.1. System for Assessment:

- Written test including theory and problem solving
- Lab reports presentation.

8.2. Assessment Criteria and Marks:

The final qualification will be based in the written test and the lab reports. There will be a single test including theory and problem solving where the skills C01, C10, CB5, G01, G09, G12, G17 and T01 will be evaluated. In addition, the students will have to attend the lab practices and provide a lab report where the skills CB5, G04, G07, G14 and G16 will be evaluated. The final grade will be computed as 0.85 times the written test grade plus 0.15 times the lab report grade. To pass this class the final grade must be equal or above 5 and both the written test and the lab report grades must be above 4.