

Energy in transport

Academic Year: (2023 / 2024)

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Department assigned to the subject: Thermal and Fluids Engineering Department

Coordinating teacher: ACOSTA IBORRA, ANTONIO

Type: Electives ECTS Credits : 3.0

Year : 4 Semester :

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

- Thermal Engineering.
- A course containing basic concepts on combustion.
- Environmental technology.

LEARNING OUTCOMES

CB1. Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study

CB2. Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.

CB3. Students have the ability to gather and interpret relevant data (usually within their field of study) in order to make judgements which include reflection on relevant social, scientific or ethical issues.

CB5. Students will have developed the learning skills necessary to undertake further study with a high degree of autonomy.

CG1. Ability to solve problems with initiative, decision-making, creativity, critical reasoning and to communicate and transmit knowledge, skills and abilities in the field of Industrial Engineering.

CG3. Ability to design a system, component or process in the field of Industrial Technologies to meet the required specifications

CG4. Knowledge and ability to apply current legislation as well as the specifications, regulations and mandatory standards in the field of Industrial Engineering.

CG5. Adequate knowledge of the concept of company, institutional and legal framework of the company. Organisation and management of companies.

CG6. Applied knowledge of company organisation.

CG8. Knowledge and ability to apply quality principles and methods.

CG9. Knowledge and ability to apply computational and experimental tools for the analysis and quantification of Industrial Engineering problems.

RA1. Knowledge and understanding: Have basic knowledge and understanding of science, mathematics and engineering within the industrial field, as well as knowledge and understanding of Mechanics, Solid and Structural Mechanics, Thermal Engineering, Fluid Mechanics, Production Systems, Electronics and Automation, Industrial Organisation and Electrical Engineering.

RA2. Engineering Analysis: To be able to identify engineering problems within the industrial field, recognise specifications, establish different resolution methods and select the most appropriate one for their solution

RA4. Research and Innovation: To be able to use appropriate methods to carry out research and make innovative contributions in the field of Industrial Engineering.

RA5. Engineering Applications: To be able to apply their knowledge and understanding to solve problems and design devices or processes in the field of industrial engineering in accordance with criteria of cost, quality, safety, efficiency and respect for the environment.

RA6. Transversal Skills: To have the necessary skills for the practice of engineering in today's society.

OBJECTIVES

By the end of the present course the students will be able to have:

- 1.- A systematic understanding of the key aspects and concepts of energy consumption in the transport sector, the main propulsive technologies, the fuels employed and their emissions.
- 2.- A coherent knowledge of working principles and energy efficiency of the main types of engines used in the road, rail, air and sea transportation as well as the emerging hybrid and electric propulsion technologies.
- 3.- The ability to apply their knowledge and understanding to identify, formulate and solve problems involving the thermal and energy characterization of the main propulsion systems by means of established methods in thermodynamics and fluids mechanics.
- 4.- The ability to select and apply relevant analytic and modelling methods in thermal and fluids engineering to characterize the thermodynamic cycles in propulsion engines.
- 5.- The ability to conduct searches of literature, and to use data bases and other sources of information.
- 6.- The ability to select and use appropriate equipment, tools and methods to evaluate in a practical way different energy consumption and losses in the land, air, and sea transport means.
- 7.- The ability to combine theory and practice to solve problems involving the characterization of the energy efficiency of a propulsive system of a given vehicle together with its energy losses and pollutant emissions.
- 8.- The ability to work effectively both as an individual and as a member of a team.
- 9.- The ability to demonstrate awareness of the health, safety and legal issues and responsibilities of engineering practice, the impact of engineering solutions in a societal and environmental context, and commit to professional ethics, responsibilities and norms of engineering practice.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Introduction:

- o Energy consumption in transport vs total energy consumption.
- o Transport sector: transport means (people vs goods).
- o Types of propulsion powerplants: thermal engines and electric motors. Reciprocating engines, gas turbines, electric motors and other systems.
- o Types of liquid and gaseous fuels and their use in transportation. Biofuels. Other ways to store energy.
- o Pollutants and their effects. Direct and indirect pollution. Atmospheric pollutants: CO₂, NO_x, SO_x, HC, CO, particles and comparison of sector emissions.

2. Reciprocating Engines in transportation:

- o Architecture and processes of reciprocating engines. Two-stroke and four-stroke engines. Spark ignition engines and compression ignition engines.
- o Power, torque and specific consumption.
- o Operation curves at full load.
- o Combustion, emission, control and mitigation of pollutants in reciprocating engines.

3. Gas turbines in transportation:

- o Architecture and processes in gas turbines.
- o Brayton cycles for power generation.
- o Gas cycle in a turbojet without and with afterburner. Gas cycle in a turbofan.
- o Efficiency and performance.
- o Combustion, emission and mitigation of pollutants in gas turbines.

4. Electric propulsion in transportation:

- o All-electric vehicles.
- o Hybrid vehicles.
- o Energy storage systems: batteries.

5. Propulsion efficiencies:

- o Resistance forces and propulsion power.
- o Efficiencies of land, air and sea transport means.

6. Auxiliary devices in transportation systems:

- o Energy consumption of auxiliary devices.
- o Refrigeration systems, HVAC, cabin pressurization, electrical and electronic systems. Other auxiliary systems.

7. Control and management of transportation systems:

- o Control and management of transportation.
- o Road, rail, air and maritime traffic. International transport modes.

LEARNING ACTIVITIES AND METHODOLOGY

The educational methodology includes:

- 1) Lectures covering the main topics of the course. In order to facilitate the learning process the students will receive support material and information to let them complete and focus on the relevant topics or interesting topics for them.
 - 2) Resolution of problems, related to the knowledge that must be acquired and above all related to the specific competences the student must develop.
 - 3) Resolution of exercises that will allow the student to consolidate the knowledge and contrast the results with the reality. This will develop the capacity of self-evaluation and the students will acquire skills and develop technical creativity.
 - 4) Reports elaboration.
- Sharing of solutions obtained by the students to answer problems in engineering and their participative correction should serve to improve their understanding of the course contents and to develop the students' ability to assess and communicate relevant information for the problem solution. Besides, this sharing of information will promote the exchange of critical (analytical) opinions between the instructor and the students or amongst the students.

ASSESSMENT SYSTEM

% end-of-term-examination/test:	40
% of continuous assessment (assignments, laboratory, practicals...):	60

The continuous assessment is based on the following criteria:

- Class participation: concise answers, connected to the ideas exposed during the course, and providing added value. For this purpose the professor will provide questions, debates, theoretical and practical exercises, etc.
- Individually solved problems.
- Teamworks.
- Midterm exam comprising one part of the course.
- Laboratory sessions.

The end-of-term-examination (final exam) will evaluate the knowledge and skills of the student acquired in the course.

To pass the course, the following two requirements need to be met:

- 1) The mark of the final exam should be equal to or greater than 2.0 over 10.
- 2) The overall mark of the course should be equal to or greater than 5.0 over 10.

BASIC BIBLIOGRAPHY

- C. R. Ferguson and A. T. Kirkpatrick Internal Combustion Engines: Applied Thermosciences, John Wiley, 2015
- J. B. Heywood Internal Combustion Engine Fundamentals, McGraw-Hill, 1988
- M. J. Moran, H. N. Shapiro, D. D. Boettner and M. B. Bailey Principles of Engineering Thermodynamics: SI version, John Wiley & Sons, 2012