Energy in transport

Academic Year: (2023 / 2024) **Review date: 07-06-2023**

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 containg basic concepts on combustion.
- Environmental technology.

SKILLS AND 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.
CB4. Students should be able to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.
CB5. Students will have developed the learning skills necessary to undertake further study with a high degree of autonomy.
CG4. Being able to do design, analysis, calculation, manufacture, test, verification, diagnosis and maintenance of energetic systems and devices.
CG7. Assess, control, and reduce the social and environmental impact of projects and facilities within the field of energy engineering.
CG10. Being able to work in a multi-lingual and multidisciplinary environment
CE20 Módulo CRI. Basic knowledge on environmental and sustainability technologies and their application.
CE1 Módulo TE. Applied knowledge on thermal engineering.
CT1. Ability to communicate knowledge orally as well as in writing to a specialized and non-specialized public.
CT2. Ability to establish good interpersonal communication and to work in multidisciplinary and international teams.
CT3. Ability to organize and plan work, making appropriate decisions based on available information, gathering and interpreting relevant data to make sound judgement within the study area.
CT4. Motivation and ability to commit to lifelong autonomous learning to enable graduates to adapt to any new situation.

By the end of this content area, students will be able to have:
RA1.2 a systematic understanding of the key aspects and concepts of the branch of energy engineering.
RA1.3 coherent knowledge of the branch of energy engineering including some at the forefront of energetic technologies;
RA2.1 the ability to apply their knowledge and understanding to identify, formulate and solve energy engineering problems using established methods;
RA2.3 the ability to select and apply relevant analytic and modelling methods.
RA4.1 the ability to conduct searches of literature, and to use data bases and other sources of information;
RA5.1 the ability to select and use appropriate equipment, tools and methods;
RA5.2 the ability to combine theory and practice to solve energy engineering problems;
RA6.1 function effectively as an individual and as a member of a team;
RA6.3 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.

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

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

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

4. Electric propulsion in transportation:
- All-electric vehicles.
- Hybrid vehicles.
- Energy storage systems: batteries.

5. Propulsion efficiencies:
- Resistance forces and propulsion power.
- Efficiencies of land, air and sea transport means.

6. Auxiliary devices in transportation systems:
- Energy consumption of auxiliary devices.
- 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) Solution of problems, related to the knowledge that must be acquired and above all related to the specific competences the student must develop.
3) Solution 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

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.

% end-of-term-examination:	40
% of continuous assessment (assigments, laboratory, practicals…):	60

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