Code: ING-IND/08 **Credits: 9**
Matter: Internal Combustion Engines
Main language of instruction: Italian
Other language of instruction: English

Teaching Staff

Head instructor
Prof. Daniele Chiappini – daniele.chiappini@unicusano.it

Introduction

The course of internal combustion engines aims to provide the fundamental notions necessary for the study and the analysis of modern internal combustion engines for transportation. The analysis is carried out for the two macro-families most commonly used for transport, i.e. spark ignition engines and compression ignition ones, with particular attention to the increase in performance and compliance with the pollutant emissions requirements. The student must be able to understand the phenomenology of the main processes
which characterize these systems and assess their impact on their functioning.
During the study, students should prepare the e-tivities in order to develop additional competences with referring to internal combustion engines problems solved through computational tools like Matlab/Octave and to write official documents with Office package or similar.

Objectives

1. *To introduce the characteristic quantities for the study of internal combustion engines and present the reference thermodynamic cycles;*
2. *To explain the main problems inherent in feeding the ICEs both by analysing trends of the volumetric efficiency and by proposing the adoption of turbochargers;*
3. *To explain the characteristics of the fuels normally used in automotive engines with illustrating the possible injection schemes;*
4. *To illustrate the turbulent characteristics of the motion inside the cylinder;*
5. *To critically analyse the combustion process with particular attention to pollutant emissions reduction techniques.*

Competencies:

knowledge and understanding: At the end of the course, the student will have demonstrated knowledge of the characteristic topics of internal combustion engines, such as geometric and performance parameters and devices for the abatement and reduction of pollutant emissions, and will have acquired the ability to analyse them. Furthermore, the student will acquire the knowledge for the evaluation of fundamental design parameters such as the volumetric efficiency. The student will acquire knowledge concerning the influence of turbulence on the thermodynamic cycle. Finally, the student will acquire knowledge on the phenomena of combustion with particular reference to the formation of pollutant emissions and the relative methods of abatement. Moreover, through the Etivity the student will acquire the ability to solve problems typical of internal combustion engines within the Octave software (or similar).

Applying knowledge and understanding: The student will be able to use the knowledge acquired at a physical/phenomenological level for the analysis of internal combustion engines for road traction; he will also be able to implement simple calculation codes for the solution of internal combustion engine problems. The Etivities are addressed to the application of theoretical knowledge to practical problems to be solved with the aid of calculation software (Octave or similar). The student will acquire the critical ability to interpret the results obtained during a numerical exercise both in terms of physical consistency of the results obtained and in terms of engineering feasibility of the identified solution.

Making judgements: The student will be able to identify the most appropriate mathematical models to describe the proposed problems, in accordance with the theoretical treatment developed during the lessons.

Communication skills: The student will develop a correct and understandable scientific language that allows to express in a clear and unambiguous way the technical knowledge acquired in the context of the problems proposed and analysed. At the end of each Etivity the student will have to draw up a technical report analysing the results obtained and critically discussing the conditions of applicability of the equations used.

Learning skills: At the end of the course the student will have knowledge of the fundamental notions necessary for the analysis of internal combustion engines. The acquired knowledge will allow him to continue his engineering studies with improved maturity and will provide him with the bases to be able to learn what will be offered in the next courses of the specialist degree in mechanical engineering. In conclusion, the student will develop the ability to apply the acquired knowledge for the resolution of unfamiliar problems that have as their object the analysis of the internal combustion engines.

Syllabus

Subject 1. *Introduction to internal combustion engines*
Subject 2. *Air supply to internal combustion engines*
Subject 3. *Dynamic effects on volumetric efficiency*
Subject 4. *Turbocharging the internal combustion engines*
Subject 5. *Fuels for internal combustion engines*
Subject 6. *Fuel injection systems*
Subject 7. *Air motion into combustion chamber*
Subject 8. *The Combustion*
Subject 9. *Formation and control of pollutant emissions*
Subject -. *Etivity 1*
Subject -. *Etivity 2*

Evaluation system and criteria

The exam consists of a written test aimed at ascertaining the abilities to analyze and re-elaborate the concepts acquired and a series of activities (Etivity) carried out during the course in virtual classes. The evaluation of the two Etivity ranges from 0 to 5 points, and it is carried out during the duration of the course. The profit exam is valued from 0 to 25 points. During the final grade evaluation, Etivity will be taken into account if and only if the mark of the written test is higher than 15/25.
The written test includes 5 questions on the entire program of the course. Each question has an evaluation between 0 and 5 points. Particular attention in the evaluation of the answers given is payed to the student's ability to reformulate the teaching material provided.
The expected learning outcomes regarding the knowledge of the topics and the ability to apply it are assessed by the written test, while the communication skills, the ability to draw conclusions and the capacity for self-learning are evaluated in-itinere through the Etivity.

Bibliography and resources

Materials to consult:

Teaching materials provided by the teacher

Recommended bibliography:

Internal Combustion Engines Fundamentals, J. B. Heywood, MacGraw-Hill