Code: ING-IND/09 **Credits: 9**
Matter: Hybrid Vehicles
Main language of instruction: Italian
Other language of instruction: English

Teaching Staff

Head instructor
Prof. Laura Tribioli - laura.tribioli@unicusano.it

Introduction

Hybrid Vehicles course aims to give the student a good knowledge of the most common alternative technologies to traditional propulsion. The course proposes to present the student with the various architectures of electric and hybrid vehicles, the fundamental concepts of on-board energy management, the various alternatives for electrochemical storage systems, the use of a fuel cell based generation systems. The course will also deal with the basic concepts of vehicle dynamics for the realization of simple zero-dimensional models of vehicles, aimed at designing simple on-board energy management strategies. These models will then be used to critically analyze the effect of the strategy on vehicle performance.
The e-tivity associated with the course develops the skills needed to simulate the operation of the main components and the entire vehicle, using a simulation code.

Objectives

The course objectives are:

1. Illustrate the fundamental motivations that drive technology towards alternative propulsion
2. Illustrate the most common configurations of hybrid and electric vehicles
3. Explain the basic concepts for modeling powertrain components and the vehicle as a whole
4. Explain the fundamental concepts for on-board energy management
5. Provide a basic knowledge for the realization of simple zero-dimensional models of hybrid vehicles

Competencies:

Knowledge and understanding The student will acquire knowledge on the architecture of electric and hybrid vehicles, on the energy management of power flows, on the various possibilities of electrochemical storage and on fuel cell based generation systems. The student will also acquire the ability to create simple vehicle models, to design and test simple management strategies.
Application of knowledge The student will be able to use the knowledge acquired for the energy and performance analysis of these systems and for the preliminary sizing of the components on board. He/she will also be able to apply the right mathematical models and the main physical laws to solve energy management problems.
Ability to draw conclusions The student will be able to identify the most appropriate models to describe the individual functional blocks of the hybrid vehicle system. The student will then be able to critically analyze different propulsion architectures for electric and hybrid propulsion vehicles.
Communication skills The student will be able to describe and support conversations about alternative propulsion, using appropriate terminology.
Ability to learn At the end of the course the student will have knowledge on fundamental concepts necessary for the energy analysis of hybrid vehicles.

Syllabus

- **Subject 1:** Introductory concepts
- **Subject 2:** Fundamentals of vehicle dynamics
- **Subject 3:** Classification of hybrid vehicles
- **Subject 4:** Fundamentals of internal combustion engines and electric drives
- **Subject 5:** Fundamentals of electrochemical storage systems
- **Subject 6:** Design of drivetrain in series configuration
- **Subject 7:** Design of drivetrain in parallel configuration
- **Subject 8:** Design of drivetrain in power-split configuration
- **Subject 9:** Fuel cell vehicles

Evaluation system and criteria

The exam usually consists of a written test lasting 90 minutes aiming to prove the student's abilities to analyze and re-elaborate the concepts acquired. In addition, one E-tivity has to be delivered at the end of the course.

The exam test will be structured in theoretical questions: 20 single-answer questions (each 1 point) and 1 open question (5 points).

Up to 6 points are assigned to the e-tivity and up to 25 points are assigned to the final written test. The score of the E-tivity will be accounted for if and only if the written test is associated with a score greater than or equal to 15. A total score of 31 will result in the final vote of 30/30 Lode.

Bibliography and resources

1. *Materials to consult:*

Lecture notes, available online, completely cover the course syllabus and are integrated by slides and video-lessons. This material is necessary and sufficient for the study of the subject.

2. *Recommended bibliography:*

- Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles (Fundamentals, Theoty and Design), CRC Press LLC
- Paolo G. Iora, Tecnologie per la Mobilità Sostenibile. Veicoli elettrici, ibridi e a fuel cell, Casa Editrice Esculapio