Course guide
320169 - VE - Electric Vehicles

Last modified: 02/04/2024

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 709 - DEE - Department of Electrical Engineering.

Degree: BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Optional subject).

Academic year: 2024 **ECTS Credits:** 6.0 **Languages:** English

LECTURER

Coordinating lecturer: Joan Montañá Puig

Others: David Romero Duran, Luis Martínez Barrios,

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Transversal:
1. SELF-DIRECTED LEARNING - Level 2: Completing set tasks based on the guidelines set by lecturers. Devoting the time needed to complete each task, including personal contributions and expanding on the recommended information sources.
2. SUSTAINABILITY AND SOCIAL COMMITMENT - Level 2. Applying sustainability criteria and professional codes of conduct in the design and assessment of technological solutions.
3. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.

TEACHING METHODOLOGY

1. Theoretical sessions: the professor introduces the theoretical foundations of the subject, concepts, methods, illustrating them with examples to facilitate understanding.
2. Practical work sessions: The sessions of practical work in the classroom and the laboratory.
3. Independent work and study exercises: Students will have to work and study individually and independently in order to assimilate the concepts, solving exercises.

LEARNING OBJECTIVES OF THE SUBJECT

Topic 1 Introduction to the subject
Topic 2. Basics of transport: basic knowledge of mechanical transmission of power. There will be emphasis on adherence, layout and aerodynamics.
Topic 3. Motors for electric traction: This topic describes the specific application of electric motors in vehicles.
Topic 4. Energy storage: An important part of electric vehicles is the energy storage.
Topic 5. Electric Vehicle (EV): Student will learn the components of electric vehicles and
functions.
Topic 6. Rail traction: One of the classic applications of electric traction is the railway. We will present different modes of traction in trains carrying special emphasis on high speed.

STUDY LOAD

Type	Hours	Percentage
Self study	90,0	60.00
Hours small group	30,0	20.00
Hours large group	30,0	20.00

Total learning time: 150 h

CONTENTS

TOPIC 1: Introduction

Description:
1.1 Introduction
1.2 History of the electric propulsion and current frame

Full-or-part-time: 4h
Theory classes: 2h
Self study : 2h

TOPIC 2: Basic knowledge of transport

Description:
2.1 Basic concepts of mechanical power transmission: friction and adhesion
2.2 Basics of aerodynamics
2.3 Basics of inertia and track

Related activities:
Activity 1: Issues and case studies in classroom.
Activity 2: Individual test.

Full-or-part-time: 18h
Theory classes: 6h
Practical classes: 2h
Self study : 10h

TOPIC 3: Motors for electric traction

Description:
3.1 DC Motors
3.2 Induction Motors
3.3 BLDC Motors
3.4 PMSM Motors
3.5 SRM Motors

Related activities:
Activity 1: Case studies in classroom.
Activity 2: Individual test.
Activity 3: Work in the laboratory.

Full-or-part-time: 38h
Theory classes: 6h
Practical classes: 4h
Laboratory classes: 4h
Self study : 24h

TOPIC 4: Energy storage

Description:
4.1 Batteries
4.2 Fuel Cells
4.4 Kinetic Batteries

Related activities:
Activity 1: Issues and case studies in classroom.
Activity 2: Individual test
Activity 3: Work in the laboratory

Full-or-part-time: 26h
Theory classes: 6h
Practical classes: 2h
Laboratory classes: 2h
Self study : 16h

TOPIC 5: Electric vehicles (EV)

Description:
5.1 EV setting
5.2 EV operation
5.3 Characteristics of traction
5.4 Effort tractor and transmission
5.5 Energy Consumption
5.6 Regenerative Braking
5.7 Hybrid Vehicles

Related activities:
Activity 1: Case studies in classroom.
Activity 2: Individual test.
Activity 3: Practice in the laboratory.

Full-or-part-time: 46h
Theory classes: 12h
Practical classes: 2h
Laboratory classes: 6h
Self study : 26h

TOPIC 6: Rail traction

Description:
6.1 Introduction to propel rail
6.2 Types of machines railway
6.3 Structure of electrified tracks

Related activities:
Activity 1: Case studies in classroom.
Activity 2: Individual test.

Full-or-part-time: 18h
Theory classes: 4h
Practical classes: 2h
Self study : 12h

GRADING SYSTEM

- Final test 35%
- Small project: 20%
- Practical work: 45 %

Practical work includes: 40 % experiments on electric vehicle drives; vehicle movement (10 %), vehicle performance (20 %), batteries (10 %), Fuel cells (10 %), visit or others (10 %). It is compulsory to attend the Practical work sessions.

The Final test will be done according to the schedule of the final exams. Unsatisfying results of the Final test could be repeated in a test to be allocated during the period of the final exams. Students with a grade lower than 5 points (unsatisfactory) can retake the test. The new grade, if it is equal or higher than 5 points, will substitute with the Final test grade with 5 points.

BIBLIOGRAPHY

Basic:

- Pistoia, Gianfranco. Electric and hybrid vehicles: power sources, models, sustainability, infrastructure and the market [on line]. Amsterdam: Elsevier, 2010 [Consultation: 09/05/2022]. Available on: https://www-sciencedirect-com.recursos.biblioteca.upc.edu/book/9780444535658/electric-and-hybrid-vehicles. ISBN 9786612879975.
- Ehsani, M.; Gao, Y.; Emadi, A. Modern electric, hybrid electric, and fuel cell vehicles: fundamentals, theory and design. 2nd ed. Boca Raton: CRC Press, 2010. ISBN 9781420053982.
- Álvarez Mántaras D.; Luque Rodríguez, P. Ingeniería e infraestructura de los transportes: ferrocarriles. Oviedo: Universidad de Oviedo, 2003. ISBN 8483173654.

Complementary:

- Savaresi, Sergio M. Active braking control systems design for vehicles [on line]. London: Springer, 2010 [Consultation: 09/05/2022]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-1-84996-350-3. ISBN 9781849963497.
- Larrodé, Emilio. Automóviles eléctricos [on line]. Barcelona: Reverté, 1997 [Consultation: 25/07/2024]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=13555. ISBN 9788429193282.
- Westbrook, Michael H. The electric car: development and future of battery, hybrid and fuel-cell cars. Six Hills Way: The Institution of Electrical Engineers, 2001. ISBN 0852960131.
- Miller, John M. Propulsion systems for hybrid vehicles. London: The Institution of Electrical Engineers, 2004. ISBN 0863413366.