Course guide
205279 - 205279 - Hydraulic Hybrid Machines

Last modified: 09/07/2024

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 729 - MF - Department of Fluid Mechanics.

Degree: BACHELOR'S DEGREE IN AUDIOVISUAL SYSTEMS ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN TEXTILE TECHNOLOGY AND DESIGN ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN AEROSPACE TECHNOLOGY ENGINEERING (Syllabus 2010). (Optional subject).
BACHELOR'S DEGREE IN AEROSPACE VEHICLE ENGINEERING (Syllabus 2010). (Optional subject).
BACHELOR'S DEGREE IN INDUSTRIAL DESIGN AND PRODUCT DEVELOPMENT ENGINEERING (Syllabus 2010). (Optional subject).
BACHELOR'S DEGREE IN INDUSTRIAL TECHNOLOGY ENGINEERING (Syllabus 2010). (Optional subject).

Academic year: 2024 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: Torrent Gelmà, Miquel

Others: De Las Heras Jimenez, Salvador Augusto
Moreno Llagostera, Hipolit

TEACHING METHODOLOGY

Two basically conceptual modules will be carried out, with basic calculations as simple as possible, to understand the analogy between fluid power and electric transmissions. Emphasis will be placed above all on the energy assessment with the aim of reducing emissions and improving efficiency. Then, in another module, different architectures that allow the use of both technologies in the same machine will be presented and finally, in the last module, presentations will be made of practical examples where the traditional mechanical/hydraulic power transmission solution is supplemented, and even replaced, by electric drives. The type of machinery to which reference will be made will be construction, agricultural or naval, this subject not dealing with vehicles to circulate on public roads.
The different modules will be presented with four POWERPOINT presentations in which, apart from the course theory, there will be links to view videos of the proposed solutions, the bibliography and problems to be done by the students and solved later in class. Everything will be integrated into four single documents, without saturating ATENEA with information, and the teaching line will be interspersed with short theoretical classes, presentation of practical examples and problems to be completed by the students, in order to enliven the lessons

LEARNING OBJECTIVES OF THE SUBJECT

At the end of the course, the students must have acquired generic knowledge of how energy is transferred in a conventional oleohydraulic machine, and the improvements that could be get with the hybridization with electrical drives. It must have the capacity to:

- Perform basic calculations to determine the efficiency of conventional oleohydraulic self-propelled machines
- Perform basic calculations to determine the efficiency of electric self-propelled machines
- Perform basic calculations to determine the possibility of storing energy in both cases (oleohydraulic accumulators and batteries)
- Enter the architectures of the oleohydraulic machines of the future that take advantage of hybridization with electrical solutions to significantly reduce gas emissions, noise emissions, and considerably improve their efficiency.

STUDY LOAD

Type	Hours	Percentage
Self study	45,0	60.00
Hours large group	30,0	40.00

Total learning time: 75 h

CONTENTS

Module 1: Power transmission with hydraulic drives

Description:
1) Magnitudes and basic calculations
2) Generation of hydraulic power. Generation efficiency (pumps).
3) Oil-hydraulic power consumption. Consumption efficiency (motors and linear actuators).
4) Control of hydraulic power. Efficiency in transport and control (pressure, flow and direction control valves).
5) Storage of hydraulic energy (accumulators)
6) Types of oleo-hydraulic architectures in machinery
6.1) Fixed displacement pumps
6.2) Load Sensing variable displacement pumps
6.3) Variable displacement pumps: Hydrostatic transmission

Specific objectives:
Introduction to oilhydraulics systems and their architectures in vehicles

Related activities:
Module 1 control

Full-or-part-time: 25h
Theory classes: 10h
Self study : 15h

Module 2: Power transmission with electric drives

Description:
1) Magnitudes and basic calculations
2) Generation of electrical power. Generation efficiency (generators)
3) Electric power consumption. Consumption efficiency (engines)
4) Control of electrical power. Efficiency in transport and control. Converters and inverters.
5) Storage of electrical energy (batteries)
6) Types of machinery electrification architectures

Specific objectives:
Introduction to electric motorization and its architectures in vehicles

Related activities:
Module 2 control

Full-or-part-time: 12h 30m
Theory classes: 5h
Self study : 7h 30m

Module 3: Hybridization. Electrification of hydraulic drives

Description:
1) Oil-hydraulic hybridization
2) Serial hybridization
3) Hybridization in parallel
4) Reduction of emissions
5) Evaluation of the efficiency of the system

Specific objectives:
Understand the advantages of hybridization from an energy point of view

Related activities:
Module 3 control

Full-or-part-time: 12h 30m
Theory classes: 5h
Self study : 7h 30m

Module 4: Practical examples of hybridization

Description:
1) Naval application
2) Construction machinery application
3) Agricultural machinery application

Specific objectives:
Show energy improvements on different machines by converting hydraulic transmission to hydraulic/electric hybrid transmission

Related activities:
Module 4 control

Full-or-part-time: 25h
Theory classes: 10h
Self study : 15h

GRADING SYSTEM

The final grade of the subject depends on the following activities:

Control at the end of each module: 40%, 4 controls with a weight of 10% of the final grade each (test 30 min a during class)
Final exam: 20%
Assigned task: 40%

EXAMINATION RULES.

- It is allowed to carry an A4 sheet as an aid in the final exam
- You must bring a calculator (not mobile phone) in the final exam
- The assigned task will be done during the course and must be presented on the day of the final exam

BIBLIOGRAPHY

Basic:
- Cundiff, John S.. Fluid power circuits and controls : Fundamentals and applications [on line]. Boca Raton, FL, 2002 [Consultation: 05/06/2024]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=2633 26. ISBN 0849309247.
- "Degree project in vehicle engineering". Prithviraj A. Jaipal. Hydraulic Hybrids [on line]. Stockholm: Kth Royal Institute of Technology School of Engineeting Sciences, 2017. [Consultation: 05/06/2024]. Available on: https://www.diva-portal.org/smash/record.jsf?pid=diva2%3a1189550&dswid=-3924.- Rydberg, K. E. . "Hydraulic Hybrids-the new generation of energy efficient drives". Proceedings of the 7th International Conference on Fluid Power Transmission and Control ICFP [on line]. [Consultation: 05/06/2024]. Available on: https://www.researchgate.net/publication/294678836_Hydraulic_Hybrids_-_The_New_Generation_of_Energy_Efficient_Drives.- Rydberg, K. E.. "Energy efficient hydraulic hybrid drives". 11: th Scandinavian International Conference on Fluid Power, SICFP'09 [on line]. Available on: https://www.researchgate.net/publication/228997144_Energy_Efficient_Hydraulic_Hybrid_Drives.

Complementary:
- Patrick Berkner. "Introduction to Using Hybrid-Electric Vehicle Technology with Traditional Hydraulic Systems in Work Vehicles". Automation Group – Electromechanical & Drives Division [on line]. [Consultation: 05/06/2024]. Available on: https://www.parkermotion.com/whitepages/work_truck_white_paper.pdf.

RESOURCES

Other resources:
4 POWERPOINT presentations with all the necessary links