COURSE DESCRIPTION CARD - SYLLABUS

Course name
Drive systems of electric vehicles

Course

Field of study
Electromobility

Year/Semester
3/5

Area of study (specialization)

Profile of study
general academic

Level of study
First-cycle studies

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture	Laboratory classes	Other (e.g. online)
30	30	
Tutorials	Projects/seminars	

Number of credit points

5

Lecturers

Responsible for the course/lecturer:
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Responsible for the course/lecturer:
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Prerequisites

Knowledge of construction and principle of operation of selected electrical machines. Electric motors - principle of operation and basic characteristics. Induction motors, synchronous motors. High speed electrical machines. Heating of electric machines. Electric drive systems: load characteristics, power electronic systems, control methods. Electric energy storage.Awareness of necessity of knowledge and acquirements extension. Ability to submission to rules standing during lectures and laboratory class. Ability to communicate with the teamwork during lectures and laboratory classes.

Course objective

Knowledge of the construction, principles of operation, characteristics, operating properties and basic methods of analysis and laboratory testing of electric vehicle drive systems, including mechatronic systems and automatic execution systems, in particular electromechanical transducers included in these systems.

Course-related learning outcomes

Knowledge

1. has knowledge about construction, principle of operation, characteristics and basic analysis methods of electric drive systems used in electric and hybrid vehicles.

2. has knowledge of the operating characteristics of electric drives and the structure of control systems, frequency and voltage converters, and knowledge of the implemented control algorithms for electric drives used in electromobility.

3. know and understand the processes occurring in the life cycle of electrical and electronic systems that are part of electromobility systems

Skills

1. has the ability to perform calculations of parameters and basic characteristics of electric vehicle propulsion systems and explain the principles of their operation.

2. has the ability to create and connect measurement systems to study the parameters, characteristics and operating properties of electric drive systems.

3. has the ability to make selected measurements in electric vehicle powertrain systems and identify the basic parameters of these systems from the measurements.

Social competences

1.have awareness of importance and understanding of different aspects and results of technical activities, taking into consideration influence on environment; awareness of responsibility for decisions think and work by creative way within the new method of energy storage and conversion.

2. think and work by creative way within the electromobility.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lectures and tutorials:
- evaluation of knowledge and skills presented in the written exam,
- frequent appraisal during exercise classes (the awarding student activity).

Laboratory classes:
- test and awarding knowledge during realization of laboratory classes,
- evaluation of student activity and appraisal both of increase of his knowledge, skills and social competences connected withvactivities in teamwork,
- evaluation of knowledge and skills related to the individual laboratory class, appraisal of the report.

Programme content

Lecture

Fundamentals of electric drive - structure of the propulsion system, types of static characteristics, active and reactive torque, four-quadrant system (motor and brake operation) in the context of electric vehicle propulsion, heating of electric machines, types of operation of electric machines. Conversion of rated power of motors, principles of selection of electric motors. Motor selection under variable load, reduction gear. Relating torque and moments of inertia to motor shaft speed, types of static mechanical characteristics of motors and working machines. Two-axis machine model - Clarke and Park transformations, space vectors, examples for permanent magnet synchronous machines (PMSM) and asynchronous machines (ASM). Scalar and vector control, Constant torque and constant power control zones. Excitation of permanent magnet synchronous machines - operation in the Field Weakening Region. Control algorithms for electrical machines FOC, DTC, MTPA, sensor and sensorless control. Dedicated drive microcontrollers (Instaspin, C2000) structure, implemented algorithms, applications. Feedback systems - angular position transducers (resolvers, tachometric generators, encoders - optical, magnetic, capacitive, incremental, absolute).

Laboratory exercises

Systems and measuring stands for testing electric drive systems with reluctance synchronous motors and permanent magnet machines. Testing of drive systems with asynchronous motors. Testing of generator braking process. Analysis and interpretation of obtained measurement results and calculations.

Teaching methods

Lectures with multimedia presentations supported laboratory exercises.

Laboratory with analysis of measurement reports prepared by students and discussions related to the measurement stand and procedures.

Bibliography

Basic

1. Jagiełło A.S.: Systemy elektromechaniczne dla elektryków, Politechnika Krakowska, Kraków, 2008

2. Puchała A.: Dynamika maszyn i układów elektromechanicznych, PWN, Warszawa, 1977.

3. Czemplik A.: Modele dynamiki układów fizycznych dla inżynierów. Zasady i przykłady konstrukcji modeli dynamicznych obiektów automatyki. WNT, Warszawa, 2008

4. Koczara W.: Wprowadzenie do napędu elektrycznego, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2012.

5. Zawirski K., Deskur J., Kaczmarek T.: Automatyka napędu elektrycznego, Wydawnictwo Politechniki Poznańskiej, Poznań 2012.

Additional

1. R. Crowder, Electric Drives and Electromechanical systems, Elsevier, 2006

2. M. S. Sarna, Electric Machines, Steady-State Theory and Dynamic Performance, West Publishing 3. Company, wyd. 2, 1994 i wyd. Następne

5. Electric Motor Drives – Modeling, Analysis and Control by R. Krishnan Pren. Hall Inc., NJ, 2001.

Breakdown of average student's workload

	Hours	ECTS
Total workload	127	5,0
Classes requiring direct contact with the teacher	72	3,0
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation) [1]	55	2,0

[1] delete or add other activities as appropriate