FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name in Polish:	**Układy napędowe pojazdów elektrycznych**
Name in English:	**Electrical drives vehicles**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Industrial Electrical Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional**
Subject code:	**ELR053217**
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30		15		
Number of hours of total student workload (CNPS):	60		30		
Form of crediting:	examination		crediting with grade		
For group of courses mark (X) final course:					
Number of ECTS points:	2		1		
including number of ECTS points for practical (P) classes :			1		
including number of ECTS points for direct teacher-student contact (BK) classes:	1.40		0.70		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. He has an advanced knowledge of the topology of power and control systems. He knows the mathematical description of methods electronics circuits. Understands methods of modulation in power converters systems
2. He has knowledge of modern methods of drive control of various types of motors (AC, induction, PMSM)
3. He is able to plan and carry out the study of complex drive systems to AC motors and DC. He is able to analyze complex systems, electric drives, plan their testing process, he can formulate and test hypotheses related to the modeling and design of components, systems and automation systems
4. He can think and act in a creative and enterprising. He can appropriately determine the priorities for the implementation of a specific task
5. He knows the rules of group work and direct a small team taking responsibility for the results of his work

SUBJECT OBJECTIVES

C1. Understanding students with the basic knowledge related to electric drives used in electric vehicles

C2. Informing student about safety of drive systems used in electric vehicles

C3. The acquisition of practical knowledge and skills necessary to build a modern drive systems for electric vehicles

SUBJECT LEARNING OUTCOMES

relating to knowledge:

PEU_W01	He has theoretically founded knowledge in the field of automation, including the knowledge necessary to understand the principles of operation of control systems used in electric vehicles, He is structured and theoretically founded knowledge in the field safety drives
PEU_W02	He has a basic knowledge of the algorithms used in modern vector control structures, He has knowledge on developments and the most important new developments in the field of electric drive vehicles

relating to skills:

PEU_U01	He understand the concept of a complete control system of electric vehicles
PEU_U02	He can to design modern control systems for complex algorithms to analyze the traffic, can think creatively and communicate knowledge of the basics of electric vehicle propulsion systems

relating to social competences:

PEU_K01	He can think and act in a creative and enterprising

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours:**
Lec 1	Introduction, credit requirements. Fundamentals drive systems used in electric vehicles.	2
Lec 2	Fundamentals drive systems used in electric vehicles.	2
Lec 3	Fundamentals drive systems used in electric vehicles.	2
Lec 4	Fundamentals of the theory of motion - an analysis of the suitability of electrical drive motor vehicles. Effect of mechanical connections to the drive.	2
Lec 5	Electric drive systems and control. Examples of solutions design and performance characteristics of electric vehicles. Analysis of the active rectifier	2
Lec 6	Electric drive systems and control. Examples of solutions design and performance characteristics of electric vehicles. Analysis of the active rectifier	2
Lec 7	Control methods of electrical drive in traction	2
Lec 8	Control methods of electrical drive in traction	2
Lec 9	Traction driver system	2
Lec 10	Traction driver system	2
Lec 11	Electric cars -review	2
Lec 12	Electric cars	2
Lec 13	Sources of electricity in electric vehicles part 1.	2
Lec 14	Sources of electricity in electric vehicles part 2. Development trends of energy technologies in transport part.1	2
Lec 15	Development trends of energy technologies in transport part.2	2
	Total hours:	**30**

Form of classes - laboratory		**Number of hours:**
Lab 1	Presentation of the Rules of Procedure Health and Safety Laboratory. Establish rules for passing. General knowledge of the workplace. Discussion of the principles of exercise.	2
Lab 2	An introduction to programming using Sim Power System package, Simulink, Matlab - simple automotive exercices	2
Lab 3	Application of AC motors controlled by a frequency converter with PWM in electric vehicles	2
Lab 4	Modelling of the voltage inverter controlled by MSI powered with lithium-ion batteries. The development of the battery charging system or return energy to the grid.	2
Lab 5	Modelling of the voltage inverter controlled by MSI powered with lithium-ion batteries. The development of the battery charging system or return energy to the grid.	2
Lab 6	Hybrid electrical vehicle modelling with rectifier works with voltage drive inverter.	2
Lab 7	Hybrid electrical vehicle modelling with rectifier works with voltage drive inverter. Analysis of the control speed and torque in the selected structure of vector controlled induction motor or PMSM	2
Lab 8	Analysis of the control speed and torque in the selected structure of vector controlled induction motor or PMSM	1
	Total hours:	**15**

TEACHING TOOLS USED
N1. N1 - Lecture with audio-visual technology, multimedia presentations, transparencies.
N2. N2 - exercises, presentation of the projects, consultations, etc

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Educational effect number**	**Way of evaluating educational effect achievement**
F1(W)	PEU_W01 PEU_W02 PEU_K01	Presence at lectures
F2(W)	PEU_W01 PEU_W02	Exam
P(W)	P=0.1*F1+0.9*F2	
F1(L)	PEU_U01 PEU_U02 PEU_K01	Activity
F2(L)	PEU_U01 PEU_U02 PEU_K01	Tests
F3(L)	PEU_U01 PEU_U02	Reports
P(L)	P=0.2*F1+0.6*F2+0.2*F3	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Koczara, Włodzimierz, Wprowadzenie do napędu elektrycznego, Warszawa: Oficyna Wydawnicza Politechniki Warszawskiej, 2012
[2] Merkisz J., Pielecha I.: Alternatywne napędy pojazdów. Wydawnictwo Politechniki Poznańskiej. Poznań 2006.
[3] Michałowski K., Ocioszyński J., Pojazdy samochodowe o napędzie elektrycznym i hybrydowym. WKiŁ, Warszawa, 1989.
[4] Kaczmarek T.: „ Napęd elektryczny robotów". Wydawnictwo Politechniki Poznańskiej, Poznań 1996
[5] Kosmol J.: „ Serwonapędy obrabiarek sterowanych numerycznie". Wydawnictwa Naukowo – Techniczne, Warszawa 1998
[6] Wiak S., Welfle H., Silniki tarczowe w napędach lekkich pojazdów elektrycznych., Łódź, Wydaw. PŁ,2001.
[8] Bisztyga K., Sterowanie i regulacja silników elektrycznych, Warszawa, WNT 1989
[9] Dąbrowski M., Projektowanie maszyn elektrycznych prądu przemiennego, WNT, Warszawa 1988r.
[10] E. Gmurczyk, A. Kundera, M. Niewiadomski, T. Płatek, Nowoczesne asynchroniczne napędy pojazdów trakcyjnych, Wiadomości Elektrotechniczne - 2006).

SECONDARY LITERATURE:

[1] Orłowska-Kowalska, Teresa, Bezczujnikowe układy napędowe z silnikami indukcyjnymi, Wrocław : Oficyna Wydawnicza Politechniki Wrocławskiej, 2003
[2] Dębicki M.: „Teoria samochodu. Teoria napędu". WNT 1969.
[3] Szumanowski A.: „Czas energii". WKiŁ 1988
[4] Mitschke M.: „Dynamika samochodu. Napęd i hamowanie". WKiŁ 1987
[5] Michałowski K., Ocioszyński J.: „Pojazdy samochodowe o napędzie elektrycznym i hybrydowym". WKiŁ 1989
[6] Szydelski Z.: „Sprzęgła, hamulce i przekładnie hydrokinetyczne". WKiŁ 1981
[7] Szklarski L., K. Jaracz, K. Viteček: „Optymalizacja układów napędowych". PWN 1989

SUBJECT SUPERVISOR

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