

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: **ELR043217**
 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 EDUCATIONAL EFFECTS*relating to knowledge:*

PEK_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

PEK_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:

PEK_U01 He understand the concept of a complete control system of electric vehicles

PEK_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:

PEK_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 exercises	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 EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation <small>F - forming (during semester) P - concluding (at semester end)</small>	Educational effect number	Way of evaluating educational effect achievement
F1(w)	PEK_W01 PEK_W02 PEK_K01	Presence at lectures
F2(w)	PEK_W01 PEK_W02	Exam
P(w)	$P=0.1 \cdot F1 + 0.9 \cdot F2$	
F1(L)	PEK_U01 PEK_U02 PEK_K01	Activity
F2(L)	PEK_U01 PEK_U02 PEK_K01	Tests
F3(L)	PEK_U01 PEK_U02	Reports
P(L)	$P=0.2 \cdot F1 + 0.6 \cdot F2 + 0.2 \cdot F3$	

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. Piatek, 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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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT ELR043217 - Electrical drives vehicles AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY **Electrical Engineering** AND SPECIALIZATION **Industrial Electrical Engineering**

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)	Subject objectives	Programme content	Teaching tool number
PEK_W01	S2ETP_W11	C.1 C.2	Lec1 Lec2 Lec3 Lec4 Lec5 Lec6 Lec7 Lec8	N.1
PEK_W02	S2ETP_W11	C.1 C.2	Lec9 Lec10 Lec11 Lec12 Lec13 Lec14 Lec15	N.1
PEK_U01	S2ETP_U09	C.1 C.2 C.3	Lab1 Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8	N.2
PEK_U02	S2ETP_U09	C.1 C.2 C.3	Lab1 Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8	N.2
PEK_K01	K2ETK_K06 K2ETK_K07	C.1 C.2 C.3	Lec1 Lec2 Lec3 Lec4 Lec5 Lec6 Lec7 Lec8 Lec9 Lec10 Lec11 Lec12 Lec13 Lec14 Lec15 Lab1 Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8	N.1 N.2