

FACULTY OF ELECTRICAL  
ENGINEERING**SUBJECT CARD**

Name in Polish: **Napędy elektryczne pojazdów**  
 Name in English: **Electrical drives vehicles**  
 Main field of study (if applicable): **Control Engineering and Robotics**  
 Specialization (if applicable): **Automation of Machines, Vehicles and Apparatus**  
 Level and form of studies: **2nd level, full-time**  
 Kind of subject: **optional**  
 Subject code: **ARR043229**  
 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. It has an advanced knowledge of the topology of power electronic systems. He knows the mathematical description of the electronics circuits. Understands methods of modulation in power converters systems
2. He has knowledge of modern electrical drives control structures of various types of motors (AC, DC, PMSM)
3. He has knowledge of advanced methods of modeling, design and testing of control systems
4. He is able to plan and carry out the study of complex electrical drive systems with AC motors and DC. Able to analyze complex systems, electric drives, plan their testing process, can formulate and test hypotheses
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 knowledge connected with the electric drives applied in electric vehicles  
 C2. Informing students about the safety problem  
 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 knowledge in the field of power electronics and control systems of modern electrical drives  
 PEK\_W02 He has knowledge on developments in the field of electric drive vehicles  
 PEK\_W03 He has theoretically founded knowledge about the safety systems in automotive

*relating to skills:*

- PEK\_U01 He is able to design modern control systems for complex algorithms to analyze the motion, can think creatively and communicate knowledge of the basics of electric vehicle systems  
 PEK\_U02 He can design automatic control systems, electronic components, including propulsion systems for selected criteria of economic performance and, if necessary, adapt existing or develop new design methods and tools Computer-aided design (CAD)

*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. The theory of motion control - an analysis of the suitability of the electric drive motor vehicles. Effect of mechanical connections to the drive.	2
Lec 2	Fundamentals drive systems used in electric vehicles. The theory of motion control - an analysis of the suitability of the electric drive motor vehicles. Effect of mechanical connections to the drive	2
Lec 3	Fundamentals drive systems used in electric vehicles. The theory of motion control - an analysis of the suitability of the electric drive motor vehicles. Effect of mechanical connections to the drive	2
Lec 4	Electric drive systems and control. Examples of solutions design and performance characteristics of electric vehicles.	2
Lec 5	Analysis of the active-controlled rectifier - possible use in the electrical drives and traction system	2
Lec 6	Electrical drives - control methods. Influence of the chosen sensors on their work. The issue of safety drives.	2
Lec 7	Electrical drives - control methods. Influence of the chosen sensors on their work. The issue of safety drives.	2
Lec 8	Traction drive system. Advantages and disadvantages of the electrical drives	2
Lec 9	Traction drive system. Advantages and disadvantages of the electrical drives	2
Lec 10	Electrical vehicles - state of the art	2
Lec 11	Electrical vehicles - state of the art	2
Lec 12	Energy sources in electrical vehicles	2
Lec 13	Hybrid vehicles. Construction, purpose of use and types of hybrids	2
Lec 14	Diesel-electric hybrid vehicles. Examples of design solutions hybrid cars	2
Lec 15	Development trends of energy technologies in transport. Assessment	2
Total hours:		30

Form of classes - project		Number of hours:
Proj 1	Presentation of the Rules of Procedure Health and Safety Laboratory. Establish rules for passing. General knowledge of the workplace. Discussion of the rules for the implementation of projects	2
Proj 2	Realisation of the project connected with control algorithm for electric vehicle.	11
Proj 3	Completion	2
Total hours:		15

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

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT		
Evaluation <i>F - forming (during semester) P - concluding (at semester end)</i>	Educational effect number	Way of evaluating educational effect achievement
F1(W)	PEK_W01 PEK_W02 PEK_W03	exam
F2(W)	PEK_W01 PEK_W02 PEK_W03	presence at the lecture
P(W)	$P=0.9 \cdot F1 + 0.1 \cdot F2$	
F1(P)	PEK_U01 PEK_U02 PEK_K01	presence at the lecture
F2(P)	PEK_U01 PEK_U02 PEK_K01	project realisation
F3(P)	PEK_U01 PEK_U02 PEK_K01	activity
P(P)	$P=0.1 \cdot F1 + 0.7 \cdot F2 + 0.2 \cdot F3$	

## 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] Drozdowski P., Wprowadzenie do napędów elektrycznych, Skrypt Politechniki Krakowskiej, Kraków 1998.
- [5] Bisztyga K., Sterowanie i regulacja silników elektrycznych, Warszawa, WNT 1989
- [6] E. Gmurczyk, A. Kundera, M. Niewiadomski, T. Piatek, Nowoczesne asynchroniczne napędy pojazdów trakcyjnych, Wiadomości Elektrotechniczne - 2006).

### SECONDARY LITERATURE:

- [1] Orłowska-Kowalska, Teresa, Bezczytnikowe 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] Szydelski Z.: „Sprzęgła, hamulce i przekładnie hydrokinetyczne”. WKiŁ 1981
- [6] Szklarski L., K. Jaracz, K. Viteček: „Optymalizacja układów napędowych”. PWN 1989
- [7] Erik Schaltz (2011). Electrical Vehicle Design and Modeling, Electric Vehicles - Modelling and Simulations, Dr. Seref Soylu (Ed.), ISBN: 978-953-307-477-1, InTech, DOI: 10.5772/20271. Available from:  
<http://www.intechopen.com/books/electric-vehicles-modelling-and-simulations/electrical-vehicle-design-and-modeling>
- [8] Lorenzo Galati, Giordano and Luca Reggiani, Vehicular Technologies - Deployment and Applications, Publisher: InTech, Chapters published February 13, 2013 under CC BY 3.0 license, DOI: 10.5772/46112  
<http://www.intechopen.com/books/vehicular-technologies-deployment-and-applications>

## SUBJECT SUPERVISOR

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### MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT **ARR043229 - Electrical drives vehicles** AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY **Control Engineering and Robotics** AND SPECIALIZATION **Automation of Machines, Vehicles and Apparatus**

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	S2AMPU_W12	C.1 C.2 C.3	Lec1 Lec2 Lec3 Lec4 Lec5 Lec6 Lec7 Lec12	N.1
PEK_W02	S2AMPU_W12	C.1 C.2 C.3	Lec8 Lec9 Lec10 Lec11 Lec12 Lec13 Lec14 Lec15	N.1
PEK_W03	S2AMPU_W12	C.1 C.2 C.3	Lec4 Lec6 Lec7 Lec8 Lec9 Lec15	N.1
PEK_U01	S2AMPU_U11	C.1 C.2 C.3	Proj1 Proj2 Proj3	N.2
PEK_U02	S2AMPU_U11	C.1 C.2 C.3	Proj1 Proj2 Proj3	N.2
PEK_K01	K2AiR_K06	C.1 C.2 C.3	Lec1 Lec2 Lec3 Lec4 Lec5 Lec6 Lec7 Lec8 Lec9 Lec10 Lec11 Lec12 Lec13 Lec14 Lec15 Proj1 Proj2 Proj3	N.1 N.2