**Nazwa przedmiotu:**

Operational Infrastructure of Electric and Hybrid Vehicles

**Koordynator przedmiotu:**

prof dr hab inż. Stanisław Radkowski, Mgr inż. Adrian Chmielewski

**Status przedmiotu:**

Obowiązkowy

**Poziom kształcenia:**

Studia I stopnia

**Program:**

Electric and Hybrid Vehicles Engineering

**Grupa przedmiotów:**

Specjalnościowe

**Kod przedmiotu:**

1150-00000-ISP-0405

**Semestr nominalny:**

7 / rok ak. 2022/2023

**Liczba punktów ECTS:**

3

**Liczba godzin pracy studenta związanych z osiągnięciem efektów uczenia się:**

The student's hours of work include: 30 hours of lectures, 25 hours of work at home (i.e: literature studies - 5 hours and 20 hours of project) and 20 hours for preparation/study to the tests .

**Liczba punktów ECTS na zajęciach wymagających bezpośredniego udziału nauczycieli akademickich:**

3 ECTS points

**Język prowadzenia zajęć:**

angielski

**Liczba punktów ECTS, którą student uzyskuje w ramach zajęć o charakterze praktycznym:**

3 points of ECTS

**Formy zajęć i ich wymiar w semestrze:**

|  |  |
| --- | --- |
| Wykład: | 30h |
| Ćwiczenia: | 0h |
| Laboratorium: | 0h |
| Projekt: | 0h |
| Lekcje komputerowe: | 0h |

**Wymagania wstępne:**

Knowledge of the fundamentals of mechatronic system design, simulation of dynamic systems , basics of Jonics and photonics, basics of fuel cells, fundamentals of electronics, software engineering, fundamentals of electrochemistry and batteries, as well as the fundamentals of thermal engines is required.

**Limit liczby studentów:**

according to the Rector regulation act

**Cel przedmiotu:**

The main aim of the lecture is to familiarize students with the development of operational infrastructure for electric and hybrid vehicles. It is very important for the students to have current stage of knowledge of the developement of electric and hybrid vehicles and their associated operational infrastructure, in particular: knowledge of development barriers, prospective technologies and the main drivers of the development of electric and hybrid vehicles in Poland and Europe.

**Treści kształcenia:**

Brief outline of the course:
1. The role and importance of infrastructure in the operational use of electric and hybrid vehicles. (Number of hours: 4)
2. Requirements and limits for vehicles with alternative propulsion (i.e.: limitations of the mass deployment of electric vehicles, risks associated with black-out)(Number of hours: 4)
3. Electrochemical energy storage and peak power sources used in hybrid and electric vehicles - construction and characteristics. (Number of hours: 4)
4. Power supplies used to charge the above. energy sources - requirements and concepts ( the types of fast charging stations and charging standards)). (Number of hours: 4)
5. Overview of other sources of peak power and energy storage for use in vehicles (e.g.: supercapacitors and flywheels). (Number of hours: 4)
6. Fuel cells - their properties and applications for the development of operational infrastructure for electric and hybrid vehicles. (Number of hours: 2)
7. Regulations and standards for the use of alternative energy sources (CEN/CENELEC/ETSI standards, Smart charging). (Number of hours: 2)
8. Development trends of the operational infrastructure of electric and hybrid vehicles. (Number of hours: 6)

**Metody oceny:**

2 tests, final grade is the average of each test. Each of the test should be passed to a minimum of 3. The final grade is the average of the grade marks obtained from the tests.

**Egzamin:**

nie

**Literatura:**

Literature:
1. Chmielewski A., Szulim P., Gregorczyk M., Gumiński R., Mydłowski T., Mączak J.: Model of an electric vehicle powered by a PV cell – a case study, 22nd International Conference on Methods and Models in Automation and Robotics (MMAR 2017), Międzyzdroje, Poland, 28
August 2017 - 31 August 2017, pp. 1009-1014, IEEE, 2017.
2. Chmielewski A., Mączak J., Szulim P.: Experimental Research and Simulation Model of Electrochemical Energy Stores, Springer International Publishing Switzerland, Advances in Intelligent Systems and Computing, Vol. 550, pp. 236-246, 2017 {DOI: https://doi.org/10.1007/
978-3-319-54042-9\_22}
3. Chmielewski A., Mączak J., Szulim P.: Experimental Research of Electrochemical Energy Storage, Springer International Publishing Switzerland, Advances in Intelligent Systems and Computing, Vol. 550, pp. 227-235, DOI https://doi.org/10.1007/978-3-319-54042-9\_21
4. Chmielewski A. , R. Gumiński, J. Mączak, S. Radkowski, P. Szulim, “Aspects of balanced development of RES and distributed micro cogeneration use in Poland: case study of a µCHP with Stirling engine,” Elsevier, Renewable & Sustainable Energy Reviews, Vol. 60, pp. 930-
952, 2016.
5. Schneider Electric webside - fast station {http://www.schneider-electric.com/en/product-range-presentation/60852-evlink-fast-charge-solution/7}.
6. J. D. Kim, M. Rahimi, “Future energy loads for a large-scale adoption of electric vehicles in the city of Los Angeles: Impacts on greenhouse gas (GHG) emissions,” Energy Policy, Vol. 73, pp. 620-630, 2014.
7. Polish Ministry of Energy - Electromobility Development Plan In Poland {http://bip.me.gov.pl/node/26453}.
8. S. Koohi-Kamalі, N.A.Rahim, H.Mokhlis, V.V.Tyagi, “Photovoltaic electricity generator dynamic modeling methods for smart grid applications: Areview,” Renewable & Sustainable Energy Reviews, Vol. 57, pp. 131-172, 2016.
9. C. Roselli, M. Sasso, “Integration between electric vehicle charging and PV system to increase self-consumption of an office application,” Energy Conversion and Management, Vol. 130, pp.130-140, 2016.
10. L. Drude, L. C. Pereira Junior, R. Rüther, “Photovoltaics (PV) and electric vehicle-to-grid (V2G) strategies for peak demand reduction in urban regions in Brazil in a smart grid environment,” Renewable Energy, Vol. 68, pp. 443-451, 2014.
11. F. Sehar, M. Pipattanasomporn, S. Rahman, “Demand management to mitigate impacts of plug-in electric vehicle fast charge in buildings with renewables,” Energy, Vol. 120, pp. 642-651, 2017.
12. Energy Regulatory Office webside {https://www.ure.gov.pl/}
13. A. Szumanowski, “Hybrid Electric Power Train Engineering and Technology: Modeling, Control, and Simulation,” IGI Global Disseminator of knowledge, 2013.
14. Directive 2009/28/EC of the council of 23 April 2009, on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.
15. EUCO169/14Conclusions-23/24October2014 ⟨http://www.consilium.europa.eu/⟩
16. Directive 2012/27/EU of the European Parliment and of the Councilof 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC.
17. Directive 2009/72/EC of the European Parliment and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive2003/54/EC.
18. International Energy Agency-Technology Roadmap-Energy Storage <⟨www.iea.org⟩>
20. Directive 2004/8/EC of the European Parliament and of the council of 11 February 2004 on the promotion of cogeneration based on a useful heat demand in the internal energy market and amending Directive92/42/EEC.
21. Directive 2014/94/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 22 October 2014 on the deployment of alternative fuels infrastructure.
22. Standardisation mandate to CEN, CENELEC and ETSI concerning the charging of electric vehicles - Mandate M/468 <https://www.cencenelec.eu/standards/Sectors/Transport/ElectricVehicles/Pages/default.aspx>
23. COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Green Infrastructure (GI) — Enhancing Europe’s Natural Capital
<http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52013DC0249&from=EN>
24. Junfu Li, Lixin Wang, Chao Lyu, Han Wang, Xuan Liu.: New method for parameter estimation of an electrochemical-thermal coupling model for LiCoO2 battery, Journal of Power Sources Vol. 307, pp. 220-230, 2016.
25. Janke W. Averaged models of pulse-modulated DC-DC power converters. Part I. Discussion of standard methods, ARCHIVES OF ELECTRICAL ENGINEERING, VOL. 61(4), pp. 609-631 2012.
26. Ahmad Saudi Samosir , Abdul Halim Mohd Yatim: Dynamic evolution control for synchronous buck DC–DC converter: Theory, model and simulation Vol. 18, pp. 663–676, 2010.

**Witryna www przedmiotu:**

Lecture: http://www.simr.pw.edu.pl/en/Faculty-of-Automotive-and-Construction-Machinery-Engineering/Studies/Fields-of-Study/Electric-and-Hybrid-Vehicle-Engineering-in-English-and-in-Polish

**Uwagi:**

No.

## Efekty przedmiotowe

### Profil ogólnoakademicki - wiedza

**Efekt 1150-00000-ISP-0405\_W1:**

1. The student knows: barriers, difficulties and challenges related to the mass deployment of electric vehicles to the Polish and European markets. 2. The student has knowledge of the influence of selected operating parameters on the life of energy generation devices and generation systems. 3. The student knows: methodology and design processes, simulation environments (e.g: Matlab & Simulink) for testing and designing work of energy generation systems (i.e: batteries, supercapacitors, flywheels and others) for electric and hybrid vehicles applications.

Weryfikacja:

Test

**Powiązane efekty kierunkowe:** K\_W17, K\_W18, K\_W19, K\_W20

**Powiązane efekty obszarowe:** T1A\_W03, T1A\_W04, T1A\_W07, T1A\_W03, T1A\_W04, T1A\_W07, T1A\_W05, T1A\_W06

**Efekt 1150-00000-ISP-0405\_W2:**

The student knows: the rules and standards (i.e. (m.in: CEN/CENELEC/ETSI) for the operation of electric and hybrid vehicles.

Weryfikacja:

Test

**Powiązane efekty kierunkowe:** K\_W19

**Powiązane efekty obszarowe:** T1A\_W05

**Efekt 1150-00000-ISP-0405\_W3:**

The student can characterize the state of Polish, European and global operational infrastructure, and their development trends.

Weryfikacja:

Test

**Powiązane efekty kierunkowe:** K\_W19

**Powiązane efekty obszarowe:** T1A\_W05

### Profil ogólnoakademicki - umiejętności

**Efekt 1150-00000-ISP-0405\_U1:**

The student can pre-design in a simulation environment and prepare requirements for a fast-loading station based on distributed generation devices for small electric cars. The student can take into account market factors and define possible risks.

Weryfikacja:

Test

**Powiązane efekty kierunkowe:** K\_U10, K\_U13, K\_U15, K\_U16, K\_U17, K\_U18, K\_U20, K\_U23, K\_U24

**Powiązane efekty obszarowe:** T1A\_U07, T1A\_U08, T1A\_U09, T1A\_U08, T1A\_U13, T1A\_U12, T1A\_U16, T1A\_U12, T1A\_U16, T1A\_U01, T1A\_U16, T1A\_U16, T1A\_U16, T1A\_U11, T1A\_U15

**Efekt 1150-00000-ISP-0405\_U2:**

The student can generally characterize, testing with using specific software the energy generation and he knows how it can be used in vehicles such as supercapacitors, fuel cells and flywheels.

Weryfikacja:

Test

**Powiązane efekty kierunkowe:** K\_U01, K\_U02, K\_U03, K\_U13, K\_U15, K\_U16, K\_U17, K\_U20, K\_U23, K\_U24

**Powiązane efekty obszarowe:** T1A\_U01, T1A\_U02, T1A\_U03, T1A\_U08, T1A\_U13, T1A\_U12, T1A\_U16, T1A\_U12, T1A\_U16, T1A\_U01, T1A\_U16, T1A\_U16, T1A\_U11, T1A\_U15

**Efekt 1150-00000-ISP-0405\_U3:**

It can replace the essential phenomena related to the service and maintenance of electrochemical batteries as energy storage and peak power source.

Weryfikacja:

Test

**Powiązane efekty kierunkowe:** K\_U01, K\_U17, K\_U23

**Powiązane efekty obszarowe:** T1A\_U01, T1A\_U01, T1A\_U16, T1A\_U11

**Efekt 1150-00000-ISP-0405\_U4:**

The student can indicate the advantages and disadvantages of hybrid and electric vehicles associated with their operation.

Weryfikacja:

Test, presentation

**Powiązane efekty kierunkowe:** K\_U01, K\_U24

**Powiązane efekty obszarowe:** T1A\_U01, T1A\_U15

**Efekt 1150-00000-ISP-0405\_U5:**

The student has knowledge about the design, simulation the powertrain of hybrid vehicles (different versions of the transmission system) and electrical which can be connected with Renewable Energy Resources.

Weryfikacja:

Test, presentation

**Powiązane efekty kierunkowe:** K\_U01, K\_U02, K\_U03, K\_U04, K\_U10, K\_U11, K\_U12, K\_U20

**Powiązane efekty obszarowe:** T1A\_U01, T1A\_U02, T1A\_U03, T1A\_U03, T1A\_U04, T1A\_U07, T1A\_U08, T1A\_U09, T1A\_U08, T1A\_U09, T1A\_U07, T1A\_U08, T1A\_U16

### Profil ogólnoakademicki - kompetencje społeczne

**Efekt 1150-00000-ISP-0405\_K1:**

The student is aware of the importance and understanding of the non-technical aspects and effects of the activity of the electric and hybrid vehicle engineer, including the impact on the enviroment.
The student is aware of development of hybrid and hybrid vehicles and environmental infrastructure, and the associated responsibility.

Weryfikacja:

Test

**Powiązane efekty kierunkowe:** K\_K01, K\_K02

**Powiązane efekty obszarowe:** T1A\_K01, T1A\_K02