COURSE DESCRIPTION CARD - SYLLABUS

Course name
Non-invasive diagnostics in electromobility [S2Elmob1>DNwE]

Course

Field of study
Electromobility

Year/Semester
1/2

Area of study (specialization)
Alternative Fuels and Energy Storage

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
15

Laboratory classes
15

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

2,00

Coordinators

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Lecturers

Prerequisites

Student should know the basic knowledge of electrical engineering, metrology, computer science and electronics.

Course objective

Getting to know selected issues in the field of non-invasive diagnostics in electromobility. Learning the basics of thermovision phenomena, familiarizing with modern measurement techniques and awareness of the need to use modern measurement systems working as an IoT node in applications related to Industry 4.0 in terms of thermal imaging measurements. Getting to know the basics of acoustic measurements. Getting to know the possibility of using machine learning methods in the field of non- invasive diagnostics in electromobility.

Course-related learning outcomes

Knowledge:

1. Student has extensive knowledge of diagnostic methods, including non-invasive, sensor technology, signal processing and analysis of measurement data.
2. Student has extensive knowledge in the field of measurements of electrical quantities and selected non-electrical quantities, also with the use of remotely controlled systems.
3. Student has in-depth knowledge of the development of experimental results.

Skills:
1. Student is able to plan and carry out experiments involving computer simulations and measurements of electrical and non-electrical quantities in electric and hybrid vehicle systems and their charging infrastructure.
2. Student is able to use a systemic approach when formulating and solving complex and unusual engineering tasks and simple research problems and, using appropriate tools and apparatus, to make a critical analysis of the operation of simple and complex electric systems of hybrid and electric vehicles.
3. Student is able to plan the process of testing devices and complex electronic and electric systems of hybrid and electric vehicles.
4. Student is able to determine the directions of further learning, organize the process of self-education and indicate the directions of professional development of other people.

Social competences:
1. Student understands that in the field of technology, knowledge and skills are rapidly devaluing, which requires their constant supplementation.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture:
evaluation of knowledge and skills by tests. The test pass threshold is 51%. Considering activities of students in the laboratory classes and/or lectures.
Laboratory:
The skills acquired during laboratory exercises are verified on the basis of reports prepared by students, and/or a final test, and/or ongoing control of students' preparation for the exercise. Passing the laboratory classes requires performing all exercises and obtaining positive grades for all verified activities.

Programme content

Lecture:
Thermovision diagnostics, including the physical phenomena underlying the thermal imaging technique and the presentation of factors affecting the accuracy of thermal imaging measurements.
Acoustic diagnostics including: sound level measurements, RTA measurement, use of correction characteristics. Electrical and non-electrical diagnostics, including: support of expert systems based on measurements of electrical quantities in systems used for electromobility,
Laboratory:
Thermal imaging diagnostics of electronic systems. Influence of interfering factors on the result of thermal imaging temperature measurement. Acoustic diagnostics, analysis of acoustic signals in LabVIEW. Electrical Diagnostics.

Course topics

Lecture:
Thermovision diagnostics, including:
- physical phenomena in the thermal imaging technique,
- construction of modern thermal imaging cameras,
- factors affecting the result of thermal imaging temperature measurement,
- thermal imaging camera processing equation,
- selected parameters of thermal imaging cameras (NEDT, IFOV, FOV),
- practical aspects of thermovision temperature measurements,
- thermovision measurement systems as an IoT node in Industry 4.0 applications.

Acoustic diagnostics including:
- noise measurements of machines and devices,

- sound level measurements, RTA measurement, use of correction characteristics.
Electrical and non-electrical diagnostics, including:
- support of expert systems based on measurements of electrical quantities in systems used for electromobility,
- senor technique in the field of transducers of non-electrical to electrical quantities in electromobility (processing characteristics, static and dynamic properties, linearity, power supply, cooperation of measuring transducers with meters - signal transmission, interaction, measurement methods).
Laboratory:
Thermal imaging diagnostics of electronic systems. Influence of interfering factors on the result of thermal imaging temperature measurement. Selected parameters of thermal imaging cameras. Practical aspects of thermal imaging temperature measurements. Acoustic diagnostics, analysis of acoustic signals in LabVIEW. Electrical Diagnostics. Expert diagnostic system based on machine learning methods. The use of Solidworks software in thermal imaging diagnostics. Non-electric to electric size converters in electromobility.

Teaching methods

Lecture: Multimedia presentations (including figures, photos, videos) with examples given on the blackboard. Theoretical issues are presented in close connection with practice.
Laboratory: performing laboratory exercises alone or in teams, with the help and under the supervision of the teacher.

Bibliography

Basic:
1. Bogusław Więcek, Gilbert De Mey: Termowizja w podczerwieni: podstawy i zastosowania. Wydawnictwo PAK, 2011.
2. Krzysztof Dziarski, Arkadiusz Hulewicz, Grzegorz Dombek, Ryszard Frąckowiak, Grzegorz Wiczyński: Unsharpness of Thermograms in Thermography Diagnostics of Electronic Elements, Sensors, 2020.
3. Krzysztof Dziarski, Arkadiusz Hulewicz, Grzegorz Dombek: Indirect Thermographic Temperature Measurement of a Power-Rectifying Diode Die, Energis, 2021.
4. Arkadiusz Hulewicz, Krzysztof Dziarski, Grzegorz Dombek: The Solution for the Thermographic Measurement of the Temperature of a Small Object, Sensors, 2021.
5. Krzysztof Dziarski, Arkadiusz Hulewicz, Grzegorz Dombek: Thermographic Measurement of the Temperature of Reactive Power Compensation Capacitors, Energis, 2021.
6. Zbigniew Krawiecki, Dariusz Gloger, Design of a measurement stand with DAQ card and semiconductor laser for recording acoustic signals, Computer Applications in Electrical Engineering, vol. 12, pp. 541-550, 2014.
7. Górny K., Kuwałek P., Pietrowski W., Increasing Electric Vehicles Reliability by Non-Invasive Diagnosis of Motor Winding Faults, Energies, vol. 14, no. 9, art. no. 2510, 2021.

Additional:
1. Infrared Thermography: Errors and Uncertainties. Waldemar Minkina, Wiley-Blackwel,l 2009.
2. Standards: JESD 51-4A, JESD 51-12.01, JESD 51-13, JESD 51-14, JESD 51-32, JESD 51-50, JESD 51-51,
JESD 51-52, JESD 51-53.
3. PN-EN 61672-1:2014-03, Elektroakustyka - Mierniki poziomu dźwięku - Część 1: Wymagania.
4. PN-ISO 7188: 2003, Akustyka - Pomiar hałasu wytwarzanego przez samochody osobowe w warunkach charakterystycznych dla jazdy przez miasto.

Breakdown of average student's workload

	Hours	ECTS
Total workload	55	2,00
Classes requiring direct contact with the teacher	30	1,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	25	1,00