# COURSE DESCRIPTION CARD - SYLLABUS

Course name
Modeling of hybrid and hydrogen drives [S2Elmob1-PAiME>MNHiW]

## 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
30

Other
0

Tutorials
0

Projects/seminars
0

## Number of credit points

3,00

## Coordinators

prof. dr hab. inż. Ireneusz Pielecha
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## Lecturers

## Prerequisites

KNOWLEDGE: the student has basic knowledge of modeling and simulation of engine processes and hybrid powertrains SKILLS: the student is able to integrate the obtained information, interpret it, draw conclusions, formulate and justify opinions SOCIAL COMPETENCES: the student is aware of the importance and understands the nontechnical aspects and effects of modeling and simulating processes in powertrain systems

## Course objective

Basic knowledge about modeling and methods of simulating engine processes, hybrid powertrain systems and hydrogen propulsion

## Course-related learning outcomes

Knowledge:
He has advanced and in-depth knowledge of the design, diagnostics and operation of powertrain systems for hybrid and electric vehicles, including traction ones; knows the basic processes occurring in the life cycle of technical systems of hybrid and electric vehicles, including traction ones (K2_W07)
Has extended and deepened knowledge in the field of modelling, analysis and synthesis of elements and

systems characteristic of hybrid and electric vehicles, including traction vehicles (K2_W11)

Skills:
Can use the knowledge of the latest technical and technological achievements in the design of unusual devices and systems in the field of electromobility (K2_U01)
Can 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 (K2_U05)
Can, when determining the functionality and designing systems and systems of electric vehicles, apply adequate analytical, simulation and experimental methods, evaluating their usefulness and limitations in advance, and adapt them to the specificity of the problem or the need to take into account unpredictable operating conditions (K2_U06)

Social competences:
Is aware of the importance of the latest scientific and technical achievements in solving research and practical problems and, if necessary, supporting expert opinions (K2_K02)

## Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcomes presented above are verified as follows: For discussion, ongoing preparation and activity in class. Written exam. Mandatory individual laboratory reports.

## Programme content

Types of models and methods of modeling. Application of models in research of technical and powertrains (conventiona and hybrid). Types and kinds of simulations and objects. Mathematical and physical modeling. Modeling and simulation of the fuel injection process. Modeling of the temperature distribution in the components of the internal combustion engine. Modeling the combustion process in SI and CI engines (methane, hydrogen, diesel). Modeling and simulation of energy flow in hybrid vehicles. Modeling energy consumption based on real driving cycles.

## Course topics

1. Types of models and methods of modeling.
2. Application of models in research of technical and powertrains (conventional and hybrid). Types and kinds of simulations and objects. Mathematical and physical modeling.
3. Modeling of the temperature distribution in the components of the internal combustion engine.
4-6. Modeling the combustion process in SI and CI engines (methane, hydrogen, diesel).
7. Modeling and simulation of energy flow in hybrid vehicles.
8. Modeling energy consumption based on real driving cycles.

## Teaching methods

1. Lecture with multimedia presentation
2. Laboratory classes - solving problems with simulation software

## Bibliography

Basic:
1. Zeigler B.P., Teoria modelowania i symulacji. PWN Warszawa, 1984
2. Sobieszczański M.: Modelowanie procesów zasilania w silnikach spalinowych. WKŁ, Warszawa 2000
3. Rychter T., Teodorczyk A., Modelowanie matematyczne roboczego cyklu silnika tłokowego. PWN, Warszawa 1980.
4. Tarnowski W., Symulacja komputerowa procesów ciągłych. Wydawnictwo Uczelniane Wyższej Szkoły Inżynierskiej, Koszalin 1996

Additional:
1. AVL FIRE instruction
2. AVL BOOST, AVL Cruise instructions

## Breakdown of average student's workload

| | Hours | ECTS |
|---|---|---|
| Total workload | 85 | 3,00 |
| Classes requiring direct contact with the teacher | 45 | 1,50 |
| Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation) | 40 | 1,50 |