Specialties on ”Electric and Hybrid Vehicle Engineering” field of study in English

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Specialty modules in course elements library – 6th semester

Year	3						Semester 6	
Nr	Subject	Institute	Ful time study				ECTS	Method of assessment
			Lecture	Excercise	Laboratory	Project		
1	Physics III	IF	2	0	0	0	2	Z2
2	Fundamentals of technical Diagnostics	IP/ZLM	1	0	1	0	2	E/Z1
3	Smart Grid / Introduction to Robotics	WE / IMRC	1	0	0	0	1	Z2
2	Fundamentals of Finite Element Method	IPBM	1	0	1	0	2	Z2/Z1
5	Project on Electric and Hybrid Drives	IMRC	2	0	0	2	4	E/Z1
6	Image Processing and Analysis	IP/ZLM	1	0	2	0	3	Z2/Z1
7	Mechatronics Systems Design	IP/ZLM	0	0	0	2	2	Z1
8	Specialization module 1	IP/IMRC	2	0	1	0	4	E/Z1
9	Specialization module 2	IP/IMRC	2	0	1	0	4	E/Z1
10	Specialization module 3	IP/IMRC	1	0	1	0	2	Z2/Z1
11	Interim Project	IP/IMRC	0	0	0	5	4	P
12	Apprenticeship		4 weeks				4^{x}	
			13	0	7	9	30	
			29					

Specialty modules in course elements library – 7th semester

Year	4						Semester 7	
Nr	Subject	Institute	Ful time study				ECTS	Method of assessment
			Lecture	Excercise	Laboratory	Project		
1	Elective module (HES)	WAiNS	2	0	0	0	2	Z2
2	Elective module (HES)	WAiNS/SiMR	2	0	0	0	2	Z2
3	Vehicle Recycling	IPBM	2	0	0	0	2	Z2
4	Specialization module 4	IP/IMRC	2	0	0	0	3	Z2
5	Specialization module 5	IP/IMRC	1	0	1	0	3	Z2/Z1
6	Specialization module 6	IP/IMRC	2	0	0	0	2	Z2
7	Diploma seminar	IP/IMRC/IPBM	0	1	0	0	1	Z1
8	Thesis	IP/IMRC	0	0	0	10	15	P
			11	1	1	10	30	
			23					

The following specialties are offered for the BSc studies in English:

- Autonomous Vehicles
- Ecological Vehicles

In case of a large number of students (at least two dean groups) two specialties will be launched.

In the case of a small number of students (one dean's group) only one specialty will be launched (third specialty - mix of the first two specialties)

- Unconventional Vehicles

Specialty ”Ecological Vehicles”

6th Semester
1. (2Lect/1Lab) – Electric and Hybrid Vehicles Engineering (IPiMR/ZNW)
2. (2Lect/1Lab) – Advanced control of electric and hybrid drives (IPiMR/ZNW)
3. (1Lect/1Lab) – Electrically controlled Continuously Variable Transmission (IPiMR/ZNW)
7th Semster
4. (2Lect) – Operational infrastructure of electric and hybrid vehicles (IPiMR/ZNW)
5. (1Lect/1Lab) – Diagnosis of electric and hybrid vehicles (IP)
6. (2Lect) – Ultralight vehicle bodies (IP)

Specialty ”Autonomous Vehicles”

6th Semester
1. (2Lect/1Lab) – Navigation of autonomous vehicles (IP/ZLM) 2. (2Lect/1Lab) – Energy harvesting in vehicles (IP) 3. (1Lect/1Lab) – Vision systems for mobile robots (WM)
7th Semster
4. (2Lect) – Support and energy-intensive structures in vehicles (IP) 5. (1Lect/1Lab) – Vehicle Informatic Systems (IP/ZLM) 6. (2Lect) – Reliability and safety of mechatronic systems (IP/ZLM)

Specialty ”Unconventional Vehicles” - mix of the first two specialties (if only one speciality will be launched)

6th Semester
1. (2Lect/1Lab) – Electric and Hybrid Vehicles Engineering (IMRC)
2. (2Lect/1Lab) – Navigation of autonomous vehicles (IP/ZLM)
3. (1Lect/1Lab) – Electrically controlled Continuously Variable Transmission (IMRC)
7th Semster
4. (2Lect) – Support and energy-intensive structures in vehicles (IP)
5. (1Lect/1Lab) – Vehicle Informatic Systems (IP/ZLM)
6. (2Lect) – Ultralight vehicle bodies (IP)

Modules in specialty „Ecological Vehicles”:

Electric and Hybrid Vehicles Engineering

/ dr hab. Yuhua Chang /dr Zhiyin Liu

- Overview of structures and hybrid electric drives. Characteristics, advantages, disadvantages.
- Components of multisource drives.
- Control of multisource drives.
- The design of electric and hybrid vehicles.
- Design rules for electric and hybrid vehicles.
- Determination of parameters of components of multisource drives.
- Selection of drive structure to the requirements of the vehicle.
- Primary and secondary power sources - an overview of the technology.
- Electrochemical batteries - different technologies, acid, gel, NiCd, NiMH, LiIon, bipolar, characteristics, emf, internal resistance, charging characteristics, SOC, SOH, load and battery life, active and passive systems for load leveling, charging systems and battery replacement in vehicles.
- Monitoring and measurement data acquisition - terminology, systems architecture, the types of signals and transducers.

Advanced Control of Electric and Hybrid Power Trains

Dr Paweł Roszczyk

- Control of energy flow and power distribution in series and parallel hybrid drive.
- The conception of master controller for electric and hybrid drive. Control strategy.
- The influence of drive control strategy on its components efficiency.
- Control methods of electric machines in four quadrants of torque – speed coordinates.
- Control methods of speed end load torque of internal combustion engine.
- The mechanical drive components - clutches, brakes and multi-gear gearboxes - the influence on drive structure and control aimed to energy saving.
- The nonlinearity problems in control of drive components.
- Systems monitoring for drive system components. Definition and indication of the battery State of Charge.
- The active and passive balancing method of the supercapacitors and batteries cells voltage.
- The fuel cell output voltage control - the adjustment of relation between hydrogen and oxygen.
- Electromechanical differential - design and modeling.
- Main control system implementation in d’Space - rapid prototyping platform.
- Fuzzy-logic control.
- Kalman filter for approximation the state of the drive components (for linear and non-linear systems).

Electrically Controlled CVTs

Dr Arkadiusz Hajduga

- The role of mechanical gears in the drive.
- The impact of the use of mechanical transmission on energy parameters of the drive system.
- Continuous Variable Transmission - definition, the idea of action and the basic characteristics in the electric and hybrid power train.
- Types of CVTs.
- Materials used in the construction of the CVTs,
- The method of selection of the range of gears in vehicles with electric and hybrid power trains
- Control methods of change of the ratio of CVT
- Control algorithm of ratio change in electric and hybrid power train - minimization of energy consumption.
- Precise control of the CVT ratio - stepper motors.
- The role and work of the stepper motor -reducer assembly in electric or hybrid power train control system - executive signals and feedbacks analysis to the correct operation of the drive - the appointment of the CVT control.
- The real arrangement of the CVT ratio change by a stepper motor.
- Control system of stepper motor.
- The planetary gear with two degrees of freedom as an example of an electrically controlled CVT - implementation of shifting.

Infrastructure Operating Electric and Hybrid Vehicles

Dr Adrian Chmielewski

- The role and importance of operational infrastructure in the use of electric and hybrid vehicles.
- Requirements and limitations for vehicles with alternative drives.
- Electrochemical energy storage and peak power sources used in hybrid and electric vehicles - structure and properties.
- Power supplies used to charge the above-mentioned energy sources - requirements and concepts.
- Review of other sources of peak power and energy storage used in vehicles - supercapacitors and flywheels.
- Fuel cells - their properties and application in vehicles.
- Regulations and standards for the use of vehicles with alternative energy sources.
- Development trends of the operational infrastructure of electric and hybrid vehicles.

Diagnosis of Electric and Hybrid Vehicles

dr Krzysztof Więcławski

- Requirements and properties of systems regarding errors and damage.
- Construction of systems and types of damage occurring in them.
- Algorithms for diagnosing the technical condition of vehicles.
- Brushless motor diagnostics in non-stationary conditions.
- Reluctance motor diagnostics in non-stationary conditions.
- Diagnostics of modern electrochemical energy storage.
- Diagnostics of control systems.
- Devices and software for fault detection.

Ultralight Vehicle Bodies

Dr Jarosław Seńko

- Definitions and classification of vehicle bodies.
- Standards and directives applied to motor vehicle bodies.
- Body design development algorithm.
- Economics, ergonomics in the body design process.
- Packaging of light vehicle bodies.
- Comfort and safety of vehicle users.
- Materials and technologies used in the construction of ultralight bodies.
- Design and operation of interior fittings.

Modules in specialty „Autonomous Vehicles”:

Navigation of autonomous vehicles

- Introduction to the task of automatic control of autonomous vehicles.
- Introduction to the global GPS positioning system.
- Introduction to the inertial positioning system. Measurement fusion methods.
- Simultaneous Localization and Mapping (SLAM) task.
- The use of vehicle dynamics models in navigation.
- Introduction to motion planning of nonholonomic mobile robots.
- Geometric description of mobile robots.
- Optimal trajectories for mobile robots.
- Feedback control using the navigation system.
- Planning a route taking into account obstacles.

Energy harvesting in vehicles

- Introduction to energy recovery
- Problems of energy recovery and accumulation in vehicles
- Recovery of energy from the braking process
- Recovering energy from waste heat
- Special materials - thermogenerators
- Thermoacoustics - using energy with acoustic signals
- Acoustic Stirling Engine
- The use of vibration energy
- Linear and nonlinear models of dynamical systems
- Mechanisms of conversion of kinetic energy into electricity - examples of solutions.

Vision systems for mobile robots

prof. dr hab. Barbara Siemiątkowska (WM)

- Human perception, modern equipment of vision systems.
- 2D, 3D cameras and 3D laser scanners.
- Contextual and context-free transformations.
- Edge detection, Hough transform, 2D image segmentation.
- Morphological and frequency transformations.
- Building maps of the mobile robot's environment, data aggregation.
- Environment recognition, data classification.
- Examples of applications of vision systems in mobile robotics, the future.

Support and energy-intensive structures in vehicles

dr hab. inż. Jarosław Seńko

- Classification of load-bearing and energy-consuming structures used in vehicles.
- Principles of designing and research methods for the construction of energy-consuming vehicles.
- Creation of computational models for energy-intensive vehicle body structures.
- Modeling of energy dissipation in numerical calculations of vehicle structures.
- Optimization of vehicle load-bearing structures.

Vehicle Informatic Systems

dr inż. Krzysztof Szczurowski

The lecture will discuss the types of systems used in vehicles, their strengths and weaknesses. The system of data transmission and coding in the on-board diagnostic systems and the use of the data transmission network will be presented in detail.

Reliability and safety of mechatronic systems

Presentation of the content of the course, discussion of the recommended literature and the rules for passing the course.

- Introduction to Reliability and Safety of Complex Objects, basic concepts.
- Risk management. Risk assessment. Risk analysis.
- Statistics issues used in the Reliability and Safety of Complex Objects.
- Characteristic functions of reliability.
- Exponential and Weibull decomposition.
- System structure function - sets of tracks and cuts.
- Qualitative methods of risk assessment.
- Tree of disability.
- Event analysis.
- FMEA - Analysis of the effects of the occurrence of defects (failures).
- Application of the FMEA method in risk analysis.
- Quantitative Risk Assessments.
- Simulation methods.
- Analytical methods of reliability assessment (physical models).
- Markov processes.
- Transition matrix method.
- State equation method. C
- alculating Mean Time To Failure (MTTF).
- Macromodels.
- Making decisions in conditions of uncertainty.