COURSE DESCRIPTION CARD - SYLLABUS

Course name
Exploatation of autonomous vehicles [N1MiBP1>EPA]

Course

Field of study
Mechanical and Automotive Engineering

Year/Semester
4/7

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
part-time

Requirements
elective

Number of hours

Lecture
27

Laboratory classes
9

Other
0

Tutorials
9

Projects/seminars
0

Number of credit points

5,00

Coordinators

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Lecturers

Prerequisites

KNOWLEDGE: Has basic knowledge of manufacturing techniques used in the engineering industry, such as casting, plastic working, reduction and incremental machining, welding and other techniques of joining materials, cutting, coating and surface treatments. Has a basic knowledge of the tribological processes occurring in machines, i.e. friction, lubrication and wear. He is aware of the latest trends in machine construction, i.e. automation and mechatronization, automation of machine design and construction processes, increased safety and comfort of operation, and the use of modern construction materials. The student has basic knowledge of the construction, operation and maintenance of motor vehicles and their assemblies, has basic knowledge in the field of automotive electronics. SKILLS: Can search catalogs and manufacturers" websites for ready-made machine components to be used in their own projects. He can develop an instruction manual and repair a simple machine from a group of machines covered by a selected specialty. He can organize and substantively manage the process of designing and operating an uncomplicated machine from a group of machines from the group covered by a selected specialty. Has the ability to self-educate with the use of modern didactic tools, such as remote lectures, websites and databases, teaching programs, e-books. The student is able to integrate the obtained information, interpret it, draw conclusions, formulate and justify opinions, has the ability to perceive, associate and interpret phenomena occurring during the work of individual systems. SOCIAL COMPETENCES: Is aware of the recognition of the importance of knowledge in solving cognitive and practical problems and consult experts

in the event of difficulties in solving the problem on their own. Is willing to think and act in an entreprising manner. The student is aware of the importance of the technical efficiency of the vehicle and understands the technical aspects and consequences of the failure for road safety.

Course objective

The objective of the course is to familiarize students with all general operational issues, including those related to the use, handling and repair of autonomous motor vehicles, in particular with methods of handling and repairing the chassis and body systems of such vehicles, as well as developing the skills to apply these methods in engineering practice.

Course-related learning outcomes

Knowledge:
M1_W14. Has basic knowledge of manufacturing techniques used in the engineering industry, such as casting, forming, reducing and incremental machining, welding and other joining techniques, cutting, coating and surface treatments.
M1_W17. Has basic knowledge of tribological processes occurring in machines, i.e. friction, lubrication and wear.
M1_W18. Is aware of the latest trends in machine construction, i.e. automation and mechatronization, automation of machine design and construction processes, increased safety and comfort of operation, the use of modern construction materials.
M1_W20. Has elementary knowledge of the life cycle of machinery, recycling of machine elements and construction and consumables.

Skills:
M1_U02. Can search in catalogs and on manufacturers" websites ready-made machine components to be used in his own projects.
M1_U09. Can develop a manual and repair a simple machine from the group of machines covered by the selected certification path.
M1_U13. Can design the technology behind a simple machine element as well as the technology for assembling and disassembling a machine.
M1_U14. Can plan and carry out the process of constructing uncomplicated machinery units or machines and formulate requirements for electronic components and automatic control systems for industry specialists in mechatronic systems.
M1_U20. Can use the experience gained in an environment professionally involved in engineering activities related to the maintenance of devices, facilities and systems typical for the field of study.
M1_U25. Can organize and substantively manage the process of designing and operating a simple machine from a group of machines from the group covered by the selected diploma path.

Social competences:
M1_K02. Is ready to recognize the importance of knowledge in solving cognitive and practical problems and to consult experts in case of difficulties in solving the problem on its own.
M1_K04. Is ready to initiate actions for the public interest.
M1_K05. Is willing to think and act in an entrepreneurial manner.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcomes presented above are verified as follows:
Written examination, consisting of 6 questions, covering general issues of handling and repair of autonomous motor vehicles, service and rpair of a selected internal combustion engine system as well as handling and repair of the indicated chassis system of the autonomous vehicle or its component.
The threshold for passing the knowledge of the subject is 50% of the points obtained from the written exam, covering all the issues specified in the course programme.
Credit for the auditorium exercises and laboratory is obtained on the basis of grades from tests and reports.

Programme content

The module programme covers the following topics:

Theory of operation and the use:
1. Operation as a phase of the product's existence
2. Operational factors affecting the condition of the vehicle
3. Vehicle operation models
4. Technological models for organizing vehicle use
5. Criteria for vehicle operation efficiency
6. Planning the supply of spare parts for the vehicle service system
7. Legal aspects of the operation of autonomous vehicles

Handling:
1. The genesis of servicing of autonomous motor vehicles
2. System of terms and handling terminology related to the operation of a autonomous motor vehicle
3. Vehicle handling systems resulting from the strategy of their operation
4. Criteria for division and classification of handling activities
5. Influence of operating conditions on vehicle handling plans and handling scopes, handling of the engine systems of an autonomous motor vehicle
6. Handling of the car body and systems of chassis of autonomous motor-car
7. The specificity of handling of autonomous hybrid and electric motor-cars

Repair:
1. Justification for the repair of the conventional an autonomous motor vehicles
2. Dismantling of assemblies and sub-assemblies. Verification of parts, completion of parts and assembly of sub-assemblies
3. Technologies for repairing systems and mechanisms of autonomous motor vehicles
4. Repair of the engine of autonomous vehicle and its chassis systems
5. Accident repairs of autonomous vehicle bodies
6. Safety issues in vehicle handling and repairs of autonomous vehicles

Course topics

The lecture programme covers the following topics:

Theory of operation and the use:
1. Operation as a phase of the product's existence. Quality of operation. Classification of operational processes. Terminology of operational theory. Operational requirements for means of transportation. Problem groups in the theory of vehicle operation.
2. Operational factors affecting the condition of the vehicle. Road conditions. Driving conditions. Transport conditions. Climatic and natural conditions. Seasonal conditions. The role of man in vehicle operation.
3. Vehicle operation models. Classification of models of technical facility operation processes. Praxeological model of the operational system (chain of use and service). Symbols of the operational condition, operational graphs.
4. Technological models for organizing vehicle use. Structural model of the usage base. Measures of the use process (quantitative characteristics) of vehicles.
5. Criteria for vehicle operation efficiency. Determining the number of vehicles necessary to perform a specific transport work. Determining the number of vehicles scheduled for current repairs.
6. Planning the supply of spare parts for the vehicle service system. Types of spare parts. Sources of supply of spare parts.
7. Legal aspects of the operation of autonomous vehicles. Discussion of the relevant legislation abroad and at home.

Handling:
1. The genesis of servicing of autonomous motor vehicles. Influence of design, production and utility factors on the process and scope of handling. Justification of handling resulting from the wear of the vehicle components (Lorenz curve and damage intensity). The place of technical handling in the chronological order of the car"s life cycle.
2. System of terms and handling terminology related to the operation of a autonomous motor vehicle - servicing, handling and inspection, service life, renewal, maintenance of the vehicle, operational potential, physical and moral wear, generating of clearances, durability, etc.
3. Vehicle handling systems resulting from the strategy of their operation. Fitness and unfitness of a motor vehicle. Principles and tendencies in handling of motor vehicles. Schedules of operations, treatments and

handling activities. Means of performing of the handling on conventional and autonomous vehicles (equipment, materials, infrastructure). Personnel for handling - their features and motivations.
4. Criteria for division and classification of handling activities. Technical support groups. Types of handling, their characteristics and analysis. Upper and lower order handling. Periodic technical handling (basic and extended). Service networks. Service outsourcing, service contracts and fleet customer.
Structure of the national handling and repair system. The place of autonomous vehicles in the motor vehicle service system.
5. Influence of operating conditions on vehicle handling plans and handling scopes. Handling of the internal combustion engine systems of an autonomous motor vehicle (piston and crank, timing, power, greasing-lubrication, cooling, ignition, electric and electronic assemblies, fuselage and head, additional equipment and devices, resulting from the construction of the autonomous vehicle).
6. Handling of the car body and systems of chassisof autonomous motor-car, with particular emphasis on cosmetic handling and undercarriage systems of a motor vehicle (powertrain - driving, braking, steering, suspension). Handling of attachments and nodes exposed to intense wear. Comfort systems support - air conditioning, heater. Handling of systems and equipment specific to the autonomous vehicle.
7. The specificity of handling of autonomous hybrid and electric motor-cars and examples of handling critical components of these vehicles. Sources of service, handling and repair data for vehicles with combustion engines and in
the case of alternative drive sources in the light of the Polish Act on electromobility and alternative drives of 11/01/2018. The specificity of operating an autonomous vehicle.

Repair:
1. Justification for the repair of the conventional an autonomous motor vehicles and examples of malfunctions defining the scope of repairs. The operational and treatment structure of the repairprocess and the characteristics of major operations. Repair terminology - scope, effort, cost. Criteria for division and types of repairs. Organizational methods of repairing motor vehicles. Repair kits.
2. Dismantling of assemblies and sub-assemblies. Completion of parts and assembly of assemblies. Verification of parts - stages and methods of verification. Part qualification criteria during verification. Sensory verification with examples. Measuring instruments and dedicated verification devices. Application of defectoscopic methods to verify parts of vehicle. Detailed overview of the verification of selected parts of a motor vehicle.
3. Technologies for repairing systems and mechanisms of passenger vehicles and trucks Types of spare parts. Sources of supply of spare parts. Examples of repairs of selected systems or accessories of autonomous motor vehicles, specifying the cause of repair, the so-called assembly hall. Remanufacturing of parts of motor vehicles. Criteria and methods of the remanufacturing and limitations of its use.
4. Repair of the engine of autonomous vehicle and its chassis systems. Repair of the body, head and piston-crank system of an internal combustion engine. Repair of the brake system. Turbocharger repair. Repair of the powertrain system, final drive and differential of a motor vehicle. Repair of the steering system and vehicle suspension. Car air conditioning system repair.
5. Accident repairs of autonomous vehicle bodies. Aims and tasks of post-accident repairs. Body repair technologies. Body and paint shop and its equipment. Bodywork repair technology. Renovation varnishing technologies. Restoration materials.
6. Safety issues in vehicle handling and repairs of autonomous vehicles. Requirements for the condition and equipment of road transport facilities. Functions of the depot, plant and repair shop for the provision of maintenance and repair services. Identification of hazards occurring in the implementation of vehicle handling and repair tasks and ways to reduce their effects. Principles of compilance of safe work at the handling and repair stations, especially in the case of automotive autonomous vehicles with hybrid and electric powertrain.

The laboratory programme covers the following topics:
1. Geometry testing and detection of clearances in the steering system.
2. Repair technology of brake system, suspension and vehicle chassis.
3. Technology for regeneration of vehicle components.
4. General diagnostics of the internal combustion engine and testing the composition of exhaust gases and noise generated by the vehicle.
5. Technical tests under SKP.

The auditorium excersises programme covers the following topics:
1. Methodology for testing the braking and suspension system of autonomous vehicle.
2. Assessment of the correctness of the repair of the braking system.

Data acquisition and evaluation criteria. Identification of the research object, theoretical basis for obtaining data from measurements, sources of evaluation criteria.
3. Algorithms for calculating the operating parameters of the braking and suspension systems. Braking efficiency index, braking uniformity, rolling resistance, ovality, distribution of braking forces between axles of autonomous vehicle.
4. Dimensional tolerance of parts used during vehicle maintenance and repairs. Fits of parts used during vehicle maintenance and repairs. Machining to the repair dimensions of parts used in vehicle repairs.
5. Documentation used in the process of repairing parts and components: repair card, technology card, instruction card in the case of autonomous vehicle.

Teaching methods

1. Lecture with a multimedia presentation - a combination of an information and problematic lecture.
2. Laboratory exercises - performing the tasks given by the teacher - practical exercises.
3. Auditorium exercises - acquiring theoretical knowledge in connection with practice.

Bibliography

Basic:
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5. Kozłowski M. (red.): Budowa i eksploatacja pojazdów, t. II - Obsługa, diagnostyka i naprawa zespołów i podzespołów. Wyd. Vogel Business Media, Wrocław, 2008 and subsequent editions.
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7. Trzeciak K.: Wyposażenie warsztatów samochodowych. Wyd. Auto, Warszawa, 2005.
8. Niziński S.: Diagnostyka samochodów osobowych i ciężarowych. Dom wydawniczy Bellona, Warszawa, 1999.
Additional:
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3. Orzełowski S.: Naprawa i obsługa pojazdów samochodowych. WSziP, Warszawa, 2008 and subsequent editions.
4. Livesey W.A., Robinson A.: The repair of vehicle bodies. Elsevier, London, New York, Tokyo, 2005.

Breakdown of average student's workload

	Hours	ECTS
Total workload	125	5,00
Classes requiring direct contact with the teacher	45	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	80	3,00