Fundusze Europejskie
Wiedza Edukacja Rozwój

Politechnika Warszawska

Unia Europejska
Europejski Fundusz Społeczny

Warsaw University of Technology

Faculty of Automotive and Construction Machinery Engineering

WARSAW UNIVERSITY OF TECHNOLOGY

Curriculum

for

Mechatronics of Vehicles and Construction Machinery
(conducted in English)

Field of Study

Full-time study

I degree study

Warsaw 2024

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1. BASIC INFORMATION ABOUT THE STUDY

1.1. Faculty: Faculty of Automotive and Construction Machinery Engineering

1.2. Field of study: Mechatronics of Vehicles and Construction Machinery

1.3. Level of study: First-cycle study

1.4. Profile of study: General academic

1.5. Form of study: Full-time study

1.6. Language of study: English

1.7. Academic discipline to which the field of study is assigned: Mechanical Engineering

1.8. Number of semesters of study: 7 semesters

1.9. Professional title awarded to graduates: Bachelors of Science

1.10. General educational objectives (description of the profile of graduates of the field of study, graduates of the specialisation):

A graduate of the Faculty of Automotive and Construction Machinery Engineering (SIMR) is characterized by: • advanced knowledge in the field of basic subjects, • interdisciplinary attitude towards solving technical problems, • ability to use modern tools of computer-aided processes of machine design, production, operation and recycling; • such graduate is also prepared to work in an international team, • knows a foreign language, • has knowledge in the field of environment protection related to operation and mechatronics control of automobiles, tractors, special purpose vehicles, construction machinery and equipment, • has practical knowledge of stemming from varied internships performed according to the curriculum.

Vehicle Mechatronics Degree Program

Within this program, I degree study provides engineers with knowledge and skills in the fields of: • construction, application and analysis of signals from sensors, actuators and IT networks of vehicles, • construction and design of vehicles and their chassis systems, • vehicle and construction machinery acoustics; comfort of use and environmental impact, • construction, properties and diagnostics of vehicle and construction machinery active and passive safety systems, • safety and diagnostics of construction machinery and vehicles, • autonomous vehicle control. Gaining the latest and practical knowledge and new qualifications in the fields of: vehicle mechanics, safety of vehicles and construction machinery, diagnostics and safety of vehicles and construction machinery, acoustics of vehicles and construction machinery and autonomous vehicles, enable graduates of this specialization to start work in automotive, electronic or automation and robotics companies.

Construction Machinery Mechatronics Degree Program

Within this program, I degree study provides engineers with knowledge and skills in the fields of: • construction and operation of construction machinery, • construction, design and operation of materials handling vehicles, including autonomous vehicles, • analysis of purpose and construction of construction machinery, • dynamic element modelling, • analysis of the purpose, construction, automation and robotization of

transport system construction machinery, • control and regulation systems of construction machinery, • design of control and regulation systems using analog and digital technique, • monitoring, control, and regulation systems of construction machinery, • dynamic analysis of construction machinery design using the latest computer methods, • programming of Logic Controllers, PLD programmable systems and microcontrollers, • designing and writing computer programs. Universal competences as well as knowledge in the fields of mechanics and mechatronics, and competent use of computer tools: Finite Element Method, CAD/CAM systems, artificial intelligence, ability to solve mechanical and mechatronics engineering problems enable graduates of this specialization to start work as constructors, technologists, members of design, operation, supervision departments of big and small companies producing and modernizing machines and equipment for automated production processes, industrial robots, technological lines etc. as operators, diagnosticians or service managers of construction machinery.

2. DESCRIPTION OF THE EFFECTS OF EDUCATION IN THIS FIELD

Intended learning outcomes

Lp.	Reference to learning outcomes in the learning area of study program	Learning outcomes for Mechatronics of Vehicles and Construction Machinery	[1] Reference – symbol I/III	[2] Reference – symbol
Knowledge				
1.	K_W01	Has knowledge of mathematics, including algebra, analysis, including mathematical methods and numerical methods desired in: 1) creating and analyzing kinematic and dynamic models of a material point, a set of material points, a rigid body, a set of rigid bodies; 2) creation and analysis of strength models, including taking into account various load states and relationships between load and deformation states; 3) the process of modeling and analyzing the structure of basic elements 3. and machine assemblies and their assemblies; 4) the process of modeling and analysis of production and other engineering processes; 4. 5) description and analysis of the operation of mechatronic systems, elements of these systems, as well as the basic physical	I.P6S_WG.o	P6U_W

		phenomena occurring in them.		
2.	K_W02	Has basic knowledge of physics including vibration and wave motion, electrodynamics, relativistic and quantum mechanics, wave optics; in the field of physical chemistry, including chemical thermodynamics, electrochemistry; in the field of organic chemistry, covering the issues of crude oil processing.	I.P6S_WG.o	P6U_W
3.	K_W03	Has structured and theoretically based knowledge of physics, including the mechanics of a material point and a rigid body, thermodynamics, fluid mechanics, electricity and magnetism to the extent necessary to understand the basic physical phenomena occurring in drive systems, structural elements of machines and vehicles and occurring in elements and systems of systems mechatronics.	I.P6S_WG.o	P6U_W
4.	K_W04	Has structured knowledge in the field of materials mechanics, including the state of stresses and strains in mechanical structure elements, necessary to conduct strength analyses.	I.P6S_WG.o	P6U_W
5.	K_W05	Has systematic knowledge of materials used in the construction of machines and mechatronic systems.	I.P6S_WG.o	P6U_W
6.	K_W06	Has structured knowledge of the principles of creating technical documentation of components and assemblies of machines and vehicles.	I.P6S_WG.o	P6U_W
7.	K_W07	Has structured knowledge of programming methodology and techniques.	I.P6S_WG.o	P6U_W
8.	K_W08	Has detailed knowledge of methods for analyzing engineering structures, including using computer systems.	I.P6S_WG.o	P6U_W
9.	K_W09	Has elementary knowledge of the life cycle and operation of work machines and vehicles, including the problems of the impact of vehicles and work machines on the natural environment.	I.P6S_WG.o III.P6S_WG	P6U_W
10.	K_W10	Has elementary knowledge of organizing and conducting engineering design processes.	I.P6S_WG.o	P6U_W
11.	K_W11	Has elementary knowledge of technological processes used in the production of vehicles and working machines, including the organization and conduct of production preparation processes.	I.P6S_WG.o	P6U_W
12.	K_W12	Has basic knowledge of the construction of mechanical, electric and hydraulic drives and their use in the construction of vehicles and working machines.	I.P6S_WG.o	P6U_W

13.	K_W13	Has elementary knowledge of the basics of control and automation, also as applied to drive systems of vehicles and work machines.	I.P6S_WG.o	P6U_W
14.	K_W14	Has elementary knowledge of the basics of communication networks in vehicles and machines.	I.P6S_WG.o	P6U_W
15.	K_W15	Has basic knowledge of metrology, knows and understands methods of measuring and extracting basic quantities characterizing machine elements and systems, knows computational methods and IT tools for analyzing experimental results.	I.P6S_WG.o	P6U_W
16.	K_W16	Knows and understands the processes of manufacturing construction elements, vehicles, working machines and mechatronic systems.	I.P6S_WG.o	P6U_W
17.	K_W17	Has structured knowledge of specialized issues related to the design, production and operation of mechatronic systems of machines and vehicles.	I.P6S_WG.o	P6U_W
18.	K_W18	Knows and understands the methodology of designing elements of mechatronic systems, as well as the methods and techniques used in design, including artificial intelligence methods and image analysis methods; knows hardware description languages and computer tools for designing and simulating circuits and systems.	I.P6S_WG.o	P6U_W
19.	K_W19	Has systematic knowledge of vehicle mechatronics and is familiar with its current state and the latest development trends.	I.P6S_WG.o	P6U_W
20.	K_W20	Has structured knowledge of specialized, interdisciplinary and multidisciplinary engineering processes in the construction of machines, vehicles and mechatronic systems.	I.P6S_WG.o	P6U_W
21.	K_W21	Has basic knowledge necessary to understand non-technical conditions of engineering activities; knows the basic principles of occupational health and safety applicable in the mechanical engineering and mechatronics industries.	I.P6S_WK	P6U_W
22.	K_W22	Has elementary knowledge of intellectual property protection and patent law.	I.P6S_WK	P6U_W
23.	K_W23	Has elementary knowledge of management, including quality management and running a business.	I.P6S_WK	P6U_W
24.	K_W24	Knows the general principles of creating and developing forms of individual entrepreneurship.	I.P6S_WK III.P6S_WK	P6U_W
Skills				
1.	K_U01	Is able to obtain information from literature, databases and other sources; is able to integrate the information obtained, interpret it, draw	I.P6S_UW.o	P6U_U

		conclusions and formulate and justify opinions.		
2.	K_U02	Able to work individually and in a team; can estimate the time needed to complete the assigned task; is able to develop and implement a work schedule ensuring that deadlines are met.	I.P6S_UO	P6U_U
3.	K_U03	Is able to develop documentation regarding the implementation of an engineering task and prepare a text containing a discussion of the results of this task.	I.P6S_UW.o III.P6S_UW.o	P6U_U
4.	K_U04	Is able to prepare and present a short presentation devoted to the results of an engineering task and participate in a discussion.	I.P6S_UK III.P6S_UW.o	P6U_U
5.	K_U05	Speaks a foreign language (at level B2 of the Common European Framework of Reference for Languages), recognized as a language of international communication in the field of study, to a degree sufficient to communicate and read and understand catalog cards, operating instructions for IT devices and tools, and similar documents.	I.P6S_UK	P6U_U
6.	K_U06	Has the ability to self-educate, among other things, to improve professional competences.	I.P6S_UU	P6U_U
7.	K_U07	Is able to use knowledge of physics, chemistry and mechanics and use known mathematical methods and models, as well as computer simulations to analyze and evaluate the operation of elements of mechatronic systems.	I.P6S_UW.o III.P6S_UW.o	P6U_U
8.	K_U08	Is able to analyze signals and simple signal processing systems in the time and frequency domain, using digital techniques and appropriate hardware and software tools.	I.P6S_UW.o III.P6S_UW.o	P6U_U
9.	K_U09	Is able to compare design solutions of elements and assemblies in terms of given operational and economic criteria.	I.P6S_UW.o III.P6S_UW.o	P6U_U
10.	K_U10	Is able to use properly selected programming environments, simulators and computer-aided design tools to simulate, design and verify elements and systems of mechatronic systems of machines and vehicles.	I.P6S_UW.o III.P6S_UW.o	P6U_U
11.	K_U11	Is able to use properly selected methods and devices enabling the measurement of basic quantities characterizing the elements of mechatronic systems.	I.P6S_UW.o III.P6S_UW.o	P6U_U
12.	K_U12	Is able to plan and carry out simulations and measurements of electrical, mechanical, optical and magnetic characteristics, as well as extraction of basic parameters characterizing materials and elements of mechatronic systems; is able to present the obtained results in	I.P6S_UW.o III.P6S_UW.o	P6U_U

		numerical and graphical form, interpret them and draw appropriate conclusions.		
13.	K_U13	Is able to design the process of testing machine elements and systems and perform their diagnosis.	I.P6S_UW.o III.P6S_UW.o	P6U_U
14.	K_U14	Is able to formulate the specification of simple mechatronic systems at the level of functions performed, also using equipment description languages.	I.P6S_UW.o III.P6S_UW.o	P6U_U
15.	K_U15	Is able to use the acquired specialist knowledge in carrying out design tasks, tasks related to the preparation of production processes and operation of mechatronic systems of machines and vehicles.	I.P6S_UW.o III.P6S_UW.o	P6U_U
16.	K_U16	Is able to use the acquired specialist knowledge in the processes of modeling and analysis of phenomena occurring in the construction of machines, vehicles and mechatronic systems.	I.P6S_UW.o III.P6S_UW.o	P6U_U
17.	K_U17	Is able to practically use knowledge in the field of specialized engineering processes occurring in the construction of mechatronic systems of machines and vehicles.	I.P6S_UW.o III.P6S_UW.o	P6U_U
18.	K_U18	Can design a simple mechatronic system using specialized software.	I.P6S_UW.o III.P6S_UW.o	P6U_U
19.	K_U19	Is able to plan the process of implementing a simple mechatronic device; can initially estimate its costs.	I.P6S_UW.o III.P6S_UW.o	P6U_U
20.	K_U20	Is able to build, run and test a designed system or a simple mechatronic system.	I.P6S_UW.o III.P6S_UW.o	P6U_U
21.	K_U21	Is able to formulate an algorithm, uses high- and low-level programming languages and appropriate IT tools to develop computer programs controlling the mechatronic system and to software microcontrollers or microprocessors controlling the mechatronic system.	I.P6S_UW.o III.P6S_UW.o	P6U_U
22.	K_U22	Is able - when formulating and solving tasks involving the design of mechatronic elements, systems and systems - to notice their non-technical aspects, including environmental, economic and legal.	I.P6S_UW.o III.P6S_UW.o	P6U_U
23.	K_U23	Is able to work in an industrial environment, demonstrating discipline, responsibility and proper attitude to work and observing the safety rules related to this work.	I.P6S_UW.o	P6U_U
24.	K_U24	Is able to assess the usefulness of routine methods and tools for solving simple engineering tasks typical of mechatronics and to select and	I.P6S_UW.o III.P6S_UW.o	P6U_U

		use appropriate methods and tools.		
Social Competences				
1.	K_K01	Understands the need and knows the possibilities of continuous education (second and third cycle studies, postgraduate studies, courses) - improving professional, personal and social competences.	I.P6S_KK	P6U_K
2.	K_K02	Is aware of the importance and understands the non-technical aspects and effects of the activities of a mechatronics engineer, including its impact on the environment and the related responsibility for decisions made.	I.P6S_KK I.P6S_KR	P6U_K
3.	K_K03	Is aware of the importance of behaving in a professional manner, observing the principles of professional ethics and respecting the diversity of views and cultures.	I.P6S_KR	P6U_K
4.	K_K04	Is aware of the responsibility for one's own work and is ready to comply with the principles of teamwork and take responsibility for jointly performed tasks.	I.P6S_KO	P6U_K
5.	K_K05	Able to think and act in an entrepreneurial manner.	I.P6S_KO	P6U_K
6.	K_K06	Is aware of the social role of a technical university graduate, and especially understands the need to formulate and communicate to society, among others: through the mass media - information and opinions regarding achievements in the field of mechatronics of vehicles and machines and other aspects of the activity of a mechatronics engineer; makes every effort to provide such information in a generally understandable manner.	I.P6S_KO I.P6S_KR	P6U_K

3. STUDY PLAN

Semesters common to all specialties

Semester 1

No.	Nname of the item	Type of classes				ECTS points	A symbol of rigor
		L	E	L	P		
1	ALGEBRA I	30	30	0	0	5	E/Z1
2	ANALYSIS I	30	15	0	0	4	E/Z1
3	BASICS OF ENGINEERING DRAWING AND DESCRIPTIVE GEOMETRY I	30	0	0	15	4	Z2/Z1
4	STRUCTURAL MATERIALS	45	0	0	0	3	Z2
5	COMPUTER TECHNIQUES I	30	0	30	0	5	Z2/Z1

6	ENVIRONMENTAL PROTECTION (HES)	30	0	0	0	2	Z2
7	CHEMISTRY	30	0	0	0	2	Z2
8	PHYSICS I	30	0	0	0	2	E
9	HISTORY OF TECHNOLOGY	15	0	0	0	1	Z2
10	INTELLECTUAL PROPERTY	15	0	0	0	1	Z2
	TOTAL	**285**	**45**	**45**	**15**	**29**	

Semester 2

No.	**Nname of the item**	**Type of classes**				**ECTS points**	**A symbol of rigor**
		L	**E**	**L**	**P**		
1	ANALYSIS II	30	30	0	0	5	E/Z1
2	DIFFERENTIAL EQUATIONS	30	30	0	0	5	E/Z1
3	ELECTRICAL AND ELECTRONICS ENGINEERING I	30	0	15	0	4	E/Z1
4	BASICS OF ENGINEERING DRAWING WITH ELEMENTS OF DESCRIPTIVE GEOMETRY II	0	0	0	45	3	Z1
5	THEORETICAL MECHANICS I	30	30	0	0	5	E/Z1
6	MANUFACTURING TECHNOLOGY	45	0	0	0	3	Z2
7	STRUCTURAL MATERIALS LABORATORY	0	0	15	0	1	Z1
8	GEOMETRY MODELLING	0	0	30	0	2	Z1
9	PHYSICS II	30	0	0	0	2	Z2
10	INTRODUCTION TO SOFTWARE ENGINEERING	0	0	15	0	1	Z1
11	Physical education	0	30	0	0	0	Z1
	TOTAL	**195**	**120**	**75**	**45**	**31**	

Semester 3

No.	**Nname of the item**	**Type of classes**				**ECTS points**	**A symbol of rigor**
		L	**E**	**L**	**P**		
1	THEORETICAL MECHANICS II	30	30	0	0	5	E/Z1
2	STRENGTH OF MATERIALS I	30	30	0	0	5	E/Z1
3	ELECTRICAL AND ELECTRONICS ENGINEERING II	15	0	15	0	2	E/Z1
4	THEORY OF MACHINES AND AUTOMATIC CONTROL	30	0	0	15	4	E/Z1
5	METROLOGY AND INTERCHANGEABILITY	15	15	0	0	2	Z2/Z1
6	FLUID MECHANICS	30	15	0	0	3	Z2/Z1
7	ADVANCED GEOMETRY MODELLING	0	0	15	0	1	Z1
8	INTRODUCTION TO MECHATRONICS	15	0	15	0	2	Z2/Z1
9	INTRODUCTION TO MICROPROCESOR SYSTEMS	15	0	15	0	2	Z2/Z1
10	Foreign language	0	60	0	0	4	Z1
11	Physical education	0	30	0	0	0	Z1
	TOTAL	**180**	**180**	**60**	**15**	**30**	

Semestr 4

No.	Nname of the item	Type of classes				ECTS points	A symbol of rigor
		L	E	L	P		
1	INTRODUCTION TO MACHINE DESIGN I	60	0	0	0	4	E
2	PROJECT ON MACHINE DESIGN I	0	0	0	30	2	Z1
3	MECHANICAL VIBRATIONS	30	15	0	0	3	E/Z1
4	THERMODYNAMICS	30	15	0	0	3	E/Z1
5	LABORATORY OF FLUID MECHANICS	0	0	15	0	1	Z1
6	DYNAMIC MEASUREMENT OF MECHANICAL QUANTITIES	30	0	0	0	2	E
7	SOFTWARE ENGINEERING	0	0	30	0	2	Z1
8	ELECTRONIC CIRCUITS IN CONTROL AND REGULATION SYSTEMS	30	0	15	0	3	Z2/Z1
9	MECHATRONICS SENSOR AND ACTUATOR SYSTEMS	15	0	15	0	3	Z2/Z1
10	AUTOMATION SYSTEMS	15	0	15	0	3	E/Z1
11	Foreign language	0	60	0	0	4	Z1
12	Physical education	0	30	0	0	0	Z1
	TOTAL	**210**	**150**	**90**	**30**	**30**	

Semester 5

No.	Nname of the item	Type of classes				ECTS points	A symbol of rigor
		L	E	L	P		
1	ELECTRIC POWER TRAINS	15	0	15	0	2	E/Z1
2	INTERNAL COMBUSTION ENGINES	30	0	15	0	3	E/Z1
3	PROJECT ON MACHINE DESIGN II	0	0	0	30	2	Z1
4	Fundamentals of Hydraulic and Pneumatic Power Trains	30	0	15	0	3	E/Z1
5	VEHICLES	30	0	15	0	3	Z2/Z1
6	CONSTRUCTION MACHINERY AND EQUIPMENT	30	0	15	0	3	Z2/Z1
7	DYNAMIC MEASUREMENT OF MECHANICAL QUANTITIES LABORATORY	0	0	15	0	1	Z1
8	INTRODUCTION TO IMAGE PROCESSING	15	0	0	0	1	Z2
9	COMPUTER SYSTEMS IN MECHATRONICS	15	0	15	0	2	Z2/Z1
10	FUNDAMENTALS OF MECHATRONIC SYSTEMS DESIGN	15	0	15	0	3	E/Z1
11	INTELLIGENT CONSTRUCTION	30	0	0	0	2	Z2
12	INTRODUCTION TO ROBOTICS REPAIR OF VEHICLE MECHATRONIC SYSTEMS	15	0	0	0	1	Z2
13	Foreign language	0	60	0	0	4	E
	TOTAL	**225**	**60**	**120**	**30**	**30**	

SPECIALTY: VEHICLE MECHATRONICS

Semester 6

No.	Nname of the item	Type of classes	ECTS	A symbol

		L	E	L	P	points	of rigor
1	PHYSICS III	30	0	0	0	2	Z2
2	INTRODUCTION TO DIAGNOSTICS	15	0	15	0	2	E/Z1
3	HYDRAULIC AND PNEUMATIC SYSTEMS	30	0	0	0	2	Z2
4	IMAGE PROCESSING AND ANALYSIS	15	0	30	0	3	Z2/Z1
5	MECHATRONICS SYSTEMS DESIGN	0	0	0	30	2	Z1
6	FUNCTIONAL MODELS OF CONSTRUCTION MACHINERY AND EQUIPMENT	15	15	0	0	2	Z2/Z1
7	DIAGNOSTICS OF MECHATRONIC SYSTEMS / DIAGNOSTIC MODELLING OF MECHATRONIC SYSTEMS	0	0	15	0	1	Z1
8	INTRODUCTION TO FINITE ELEMENT METHOD	15	0	15	0	2	Z2/Z1
9	VEHICLE MECHATRONICS	30	0	15	0	4	E/Z1
10	VEHICLE POWER TRAINS	30	0	15	0	3	Z2/Z1
11	ON-BOARD DIAGNOSTICS OF VEHICLES	30	0	15	0	3	Z2/Z1
12	INTERIM THESIS	0	0	0	75	4	P
13	APPRENTICESHIP	4 tygodnie				4*	
	TOTAL	**210**	**15**	**120**	**105**	**30**	

*) ECTS points for practice are not added to other ECTS points

Semester 7

No.	Nname of the item	Type of classes				ECTS points	A symbol of rigor
		L	E	L	P		
1	ECONOMY	30	0	0	0	2	Z2
2	HUMANITIES/ENONOMY SUBJECT (HES)	30	0	0	0	2	Z2
3	RELIABILITY AND SAFETY OF MECHATRONIC SYSTEMS PLM – DATABASE APPROACH	30	0	0	0	2	Z2
4	AUTONOMOUS VEHICLES	30	0	0	0	3	Z2
5	INFORMATION SYSTEMS IN VEHICLES	15	0	15	0	3	Z2/Z1
6	VEHICLE ACOUSTICS	15	0	15	0	2	Z2/Z1
7	DIPLOMA SEMINAR	0	15	0	0	1	Z1
8	THESIS	0	0	0	150	15	P
	TOTAL	**150**	**15**	**30**	**150**	**30**	

SPECIALTY: MECHATRONICS OF WORK MACHINES

Semester 6

No.	Nname of the item	Type of classes				ECTS points	A symbol of rigor
		L	E	L	P		
1	PHYSICS III	30	0	0	0	2	Z2
2	INTRODUCTION TO DIAGNOSTICS	15	0	15	0	2	E/Z1
3	HYDRAULIC AND PNEUMATIC SYSTEMS	30	0	0	0	2	Z2
4	IMAGE PROCESSING AND ANALYSIS	15	0	30	0	3	Z2/Z1
5	MECHATRONICS SYSTEMS DESIGN	0	0	0	30	2	Z1
6	FUNCTIONAL MODELS OF CONSTRUCTION	15	15	0	0	2	Z2/Z1

	MACHINERY AND EQUIPMENT						
7	DIAGNOSTICS OF MECHATRONIC SYSTEMS / DIAGNOSTIC MODELLING OF MECHATRONIC SYSTEMS	0	0	15	0	1	Z1
8	INTRODUCTION TO FINITE ELEMENT METHOD	15	0	15	0	2	Z2/Z1
9	AUTOMATION OF CONSTRUCTION MACHINERY AND EQUIPMENT	30	0	15	0	4	E/Z1
10	CONSTRUCTION MACHINERY	30	0	15	0	3	Z2/Z1
11	PASSENGER LIFTS	30	0	15	0	3	Z2/Z1
12	INTERIM THESIS	0	0	0	75	4	P
13	APPRENTICESHIP	4 tygodnie				4*	
	TOTAL	**210**	**15**	**120**	**105**	**30**	

*) ECTS points for practice are not added to other ECTS points

Semester 7

No.	**Nname of the item**	**Type of classes**				**ECTS points**	**A symbol of rigor**
		L	**E**	**L**	**P**		
1	ECONOMY	30	0	0	0	2	Z2
2	HUMANITIES/ENONOMY SUBJECT (HES)	30	0	0	0	2	Z2
3	RELIABILITY AND SAFETY OF MECHATRONIC SYSTEMS PLM – DATABASE APPROACH	30	0	0	0	2	Z2
4	*BASICS OF ELECTRO-MECHANICAL HYBRID DRIVES*	30	0	0	0	3	Z2
5	*BASICS OF MODELING AND CONTROL OF CONSTRUCTION MACHINERY & EQUIPMENT*	15	0	15	0	3	Z2/Z1
6	*SYSTEMS FOR MONITORING CONSTRUCTION MACHINERY AND EQUIPMENT*	15	0	15	0	2	Z2/Z1
7	DIPLOMA SEMINAR	0	15	0	0	1	Z1
8	THESIS	0	0	0	150	15	P
	TOTAL	**150**	**15**	**30**	**150**	**30**	

4. STRUCTURE OF THE EDUCATIONAL PROGRAM

GENERAL AND BASIC SUBJECTS

BASIC SUBJECTS

No.	**Nname of the item**	**SEMESTER**	**Type of classes**				**Punkty ECTS**	**A symbol of rigor**
			L	**E**	**L**	**P**		

I.	**MATHEMATICS**							
I.1.	Analysis I	1	30	30	0	0	5	E/Z1
I.2.	Algebra	1	30	15	0	0	4	E/Z1
I.3.	Analysis II	2	30	30	0	0	5	E/Z1
I.4.	Differential equations	2	30	30	0	0	5	E/Z1
I.5	TOTAL		120	105			19	
II.	Chemistry	1	30	0	0	0	2	Z2
III.	**PHYSICS AND MECHANICS**							
III.1	Physics I	1	30	0	0	0	2	E
III.2	Physics II	2	30	0	0	0	2	Z2
III.3	General Mechanics I	2	30	30	0	0	5	E/Z1
III.4	General Mechanics II	3	30	30	0	0	5	E/Z1
III.5	Fluid mechanics	3	30	15	0	0	3	Z2/Z1
III.6	Fluid Mechanics Laboratory	4	0	0	15	0	1	Z1
III.7	Physics III	6	30	0	0	0	2	Z2
III.8	TOTAL		180	75	15		20	
IV	**CONSTRUCTION MATERIALS**							
IV.1.	Construction Materials	1	45	0	0	0	3	Z2
IV.2.	Construction Materials Laboratory	2	0	0	15	0	1	Z1
IV.3	**TOTAL**		**45**		**15**		**4**	
V.	Strength of materials I	3	30	30	0	0	5	E/Z1
VI.	**INFORMATION TECHNOLOGY**							
VI.1.	Computer Techniques	1	30	0	30	0	5	Z2/Z1
VI.2.	Introduction to Software Engineering	2	0	0	15	0	1	Z1
VI.	**TOTAL**		**30**		**45**		**6**	
VII.	ELECTRICAL TECHNOLOGY AND ELECTRONICS							
VII.1	Electrical and Electronics Engineering I	2	30	0	15	0	4	E/Z1
VII.2	Electrical Engineering and Electronics II	3	15	0	15	0	2	E/Z1
VII.3.	**TOTAL**		**45**		**30**		**6**	
VIII	Thermodynamics	3	30	15	0	0	3	E/Z1
	TOTAL		**510**	**225**	**105**		**65**	

GENERAL SUBJECTS

No.	Nname of the item	SEMESTER	Type of classes				Punkty ECTS	A symbol of rigor
			L	E	L	P		
I.	Environmental protection	1	30	0	0	0	2	Z2
II	**HES subjects**							
II.1.	History of Technology (HES)	1	15	0	0	0	1	Z2
II.2.	Intellectual Property+Health and Safety (HES)	1	15	0	0	0	1	Z2

II.3.	Economics (HES)	7	30	0	0	0	2	Z2
II.4.	Elective Subject (HES)	7	30	0	0	0	2	Z2
II.5.	**TOTAL**		**90**				**6**	
III.	**FOREIGN LANGUAGEs**							
III.1.	Foreign language 1	3	0	60	0	0	4	Z1
III.2.	Foreign language 2	4	0	60	0	0	4	Z1
III.3.	Foreign language 3	5	0	60	0	0	4	E
III.4.	**TOTAL**			**180**			**12**	
IV.	**PHYSICAL EDUCATION**							
IV.1	Physical education 1	2	0	30	0	0	0	Z1
IV.2	Physical education 2	3	0	30	0	0	0	Z1
IV.3.	Physical education 3	4	0	30	0	0	0	Z1
IV.3	**TOTAL**			**90**				
	TOTAL		**120**	**270**			**20**	

CORE SUBJECTS

No.	Nname of the item	SEMESTER	Type of classes				Punkty ECTS	A symbol of rigor
			L	E	L	P		
1	**BASICS OF CONSTRUCTION NOTATION**							
1.1.	Basics of Struct Writing with Descriptive Geometry Elements I	1	30	0	0	15	3	Z2/Z1
1.2.	Fundamentals of Structuring with Descriptive Geometry Elements II	2	0	0	0	45	3	Z1
1.3.	**TOTAL**		**30**			**60**	**6**	
2.	**MACHINE CONSTRUCTION BASICS**							
2.1	Fundamentals of Machine Design	4	60	0	0	0	4	E
2.2.	Designing the Fundamentals of Machine Construction I	4	0	0	0	30	2	Z1
2.3.	Design of the Fundamentals of Machine Construction II	5	0	0	0	30	2	Z1
2.4.	**TOTAL**		**60**			**120**	**8**	
3	**GEOMETRIC MODELING**							
3.1.	Geometric Modeling *)	2	0	0	30	0	2	Z1
3.2.	Advanced Geometric Modeling *)	3	0	0	15	0	1	Z1
3.3.	**TOTAL**				**45**		**3**	
4	**Workshop**	**1**	**0**	**0**	**15**	**0**	**0**	**Z1**
5	**Technology**	**2**	**45**	**0**	**0**	**0**	**3**	**Z2**
6	**Machine Theory and Fundamentals of Automation**	**3**	**30**	**0**	**0**	**15**	**4**	**E/Z1**
7	**Introduction to Mechatronics**	**3**	**15**	**0**	**15**	**0**	**2**	**Z2/Z1**

8	**Introduction to Microprocessor Systems**	**3**	**15**	**0**	**15**	**0**	**2**	**Z2/Z1**
9	**Mechanical vibration**	**4**	**30**	**15**	**0**	**0**	**3**	**E/Z1**
10	**Software Engineering**	**4**	**0**	**0**	**30**	**0**	**2**	**Z1**
11	**Computer systems in mechatronics**	**5**	**15**	**0**	**15**	**0**	**2**	**Z2/Z1**
12	**Metrology & Interchangeability**	**3**	**15**	**15**	**0**	**0**	**2**	**Z2/Z1**
13	**MEASUREMENTS OF DYNAMIC VALUES**							
13.1	Measurements of dynamic quantities	4	30	0	0	0	2	E
13.2.	Laboratory for the measurement of dynamic quantities	5	0	0	15	0	1	Z1
13.3.	**TOTAL**		**30**		**15**		**3**	
14	**Electronics in control and regulation systems**	**4**	**30**	**0**	**15**	**0**	**3**	**Z2/Z1**
15	**Mechatronic Sensor and Actuator Systems**	**4**	**15**	**0**	**15**	**0**	**3**	**Z2/Z1**
16	**Automation systems**	**4**	**15**	**0**	**15**	**0**	**3**	**E/Z1**
17	**Electric drives**	**5**	**15**	**0**	**15**	**0**	**2**	**E/Z1**
18	**Internal combustion engines**	**5**	**30**	**0**	**15**	**0**	**3**	**E/Z1**
19	**Vehicles**	**5**	**30**	**0**	**15**	**0**	**3**	**Z2/Z1**
20	**Work machines**	**5**	**30**	**0**	**15**	**0**	**3**	**Z2/Z1**
21	**IMAGE PROCESSING**							
21.1	Introduction to Computer Vision	5	15	0	0	0	1	Z2
21.2	Image Processing and Analysis	6	15	0	30	0	3	Z2/Z1
21.3	**TOTAL**		**30**		**30**		**4**	
22.	**DESIGNING MECHATRONIC SYSTEMS**							
22.1.	Fundamentals of mechatronic system design	5	15	0	15	0	3	E/Z1
22.2	Design of mechatronic systems	6	0	0	0	30	2	Z1
22.3	**TOTAL**		**15**		**15**	**30**	**5**	
23.	**Intelligent Designs**	**5**	**30**	**0**	**0**	**0**	**2**	**Z2**
24	**Introduction to Robotics / Repair of Mechatronic Vehicle Systems**	**5**	**15**	**0**	**0**	**0**	**1**	**Z2**
25.	**Basics of hydraulic drives. and pneumatic**	**5**	**30**	**0**	**15**	**0**	**3**	**E/Z1**
26	**Basics of diagnostics**	**6**	**15**	**0**	**15**	**0**	**2**	**E/Z1**
27	**Diagnostics of mechatronic systems. / Diagnostic modelling of mechatronic systems**	**6**	**0**	**0**	**15**	**0**	**1**	**Z1**
28	**Hydraulic & Pneumatic Systems**	**6**	**30**	**0**	**0**	**0**	**2**	**Z2**
29	**Functional models of working**	**6**	**15**	**15**	**0**	**0**	**2**	**Z2/Z1**

	machines							
30	**FEM Basics**	**6**	**15**	**0**	**15**	**0**	**2**	**Z2/Z1**
31	**Reliability and safety of mechatronic systems. /PLM - database approach**	**7**	**30**	**0**	**0**	**0**	**2**	**Z2**
32	**Transitional work**	**6**	**0**	**0**	**0**	**75**	**4**	**P**
33	**Apprenticeship**	**6**					**4**	**P**
34	**Diploma Seminar**	**7**	**0**	**15**	**0**	**0**	**1**	**Z1**
35	**Thesis**	**7**	**0**	**0**	**0**	**150**	**15**	**P**
	TOTAL		**675**	**60**	**360**	**450**	**107***	

* Student internship not included

SUBJECTS WITHIN A GIVEN SPECIALIZATION OF EDUCATION

SPECIALTY: VEHICLE MECHATRONICS

No.	**Nname of the item**	**SEMESTER**	**Type of classes**				**Punkty ECTS**	**A symbol of rigor**
			L	**E**	**L**	**P**		
1	Vehicle mechatronics	6	30	0	15	0	4	E/Z1
2	Vehicle powertrains	6	30	0	15	0	3	Z2/Z1
3	On-board vehicle diagnostics	6	15	0	15	0	3	Z2/Z1
4	Autonomous Vehicles	7	30	0	0	0	3	Z2
5	Vehicle Information Systems	7	15	0	15	0	3	Z2/Z1
6	Vehicle acoustics	7	15	0	15	0	2	Z2/Z1
	TOTAL		**135**		**75**		**18**	

SPECIALTY: MECHATRONICS OF WORK MACHINES

No.	**Nname of the item**	**SEMESTER**	**Type of classes**				**Punkty ECTS**	**A symbol of rigor**
			L	**E**	**L**	**P**		
1	Automation of working machines	6	30	0	15	0	4	E/Z1
2	Construction Machinery	6	30	0	15	0	3	Z2/Z1
3	Passenger lifts	6	15	0	15	0	3	Z2/Z1
4	Fundamentals of electromechanical hybrid drives	7	30	0	0	0	3	Z2
5	Fundamentals of Modeling and Control of Working Machines	7	15	0	15	0	3	Z2/Z1
6	Monitoring systems for working machines	7	15	0	15	0	2	Z2/Z1
	TOTAL		**135**		**75**		**18**	

1) The total number of ECTS points that a student must obtain in classes requiring direct participation of academic teachers:

The total number of ECTS points that a student must obtain in classes requiring direct participation of academic teachers:

a) Specialization: Vehicle Mechatronics - 118 ECTS points,

b) Specialization: Mechatronics of Work Machines - 118 ECTS points

2) The total number of ECTS points that a student must obtain as part of basic science classes to which the learning outcomes for a specific field or level of education relate: 65 ECTS points

3) The total number of ECTS points that a student must obtain as part of practical classes, such as laboratory and project classes:

a) Specialization: Vehicle Mechatronics – 85 ECTS points,

b) Specialization: Mechatronics of Work Machines - 86 ECTS points

4) The minimum number of ECTS points that a student must obtain by completing educational modules offered in another field of study or in university-wide classes:

No.	**Name of the item**	**Number of points ECTS**
1	**Foreign language I**	4
2.	**Foreign language II**	4
3.	**Foreign language III**	4
4.	**HES subjects ***	6*
	TOTAL	**18**

5. DESCRIPTION OF TEACHING MODULES (SUBJECTS)

Description of a Subject		
SUBJECT: ALGEBRA I		
Subject code	1120-00000-ISA-0102	
Subject version	Version I	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Mathematics and Information Science	
B. General characteristics of the subject		
Subject kind	Basic	
Subject group	Mathematics	
Subject level	Basic	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	I	
Pre-requisites	Knowledge of mathematics at the second school level	
Limit of number of students	According to University Regulations	
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Knowledge of selected departments of linear algebra and analytic geometry, necessary for studying major subjects.	
Learning outcomes	See **TABLE No 1**	
Form of classes and their duration	Lecture	30
	Practicals	15
	Laboratory	
	Project	
Learning content	Lecture: 1. The body of complex numbers, the algebraic form of a complex number. 2. Module and argument of a complex number, geometrical interpretation. 3. Trigonometric form of a complex number, exponentiation and elementary roots of complex numbers, de Moivre formula. 4. Polynomials in the complex domain, Bezout's theorem, the basic theorem of algebra. 5. Definition of matrices, operations on matrices. 6. Definition of determinant, properties of determinants, Sarrus pattern. 7. Inverse matrix. 8. Matrix form of a system of linear equations, Cramer systems. 9. Row of matrices, the Kronecker-Capelli theorem. 10. Gauss elimination method. 11. Conical curves. 12. Vectors in space, scalar and vector product, mixed product. 13. Equations of the plane and the straight line, the mutual positions of simple points and planes in space. 14. Second degree surfaces. 15. Rotating surfaces.	

	16. Cylindrical and conical surfaces. Practicals: 1. Calculation of the values of expressions in the complex domain. 2. Determination of the module and argument of a complex number, geometric interpretation of sets of numbers on a complex plane. 3. Determination of the trigonometric form of a complex number, exponentiation and the roots of complex numbers. 4. Determination of polynomial elements in the complex domain, 5. Distribution of polynomials into factors, solving algebraic equations. 6. Performing actions on matrices. 7. Calculation of matrix determinants by Laplace method. 8. The use of matrix elemental transformations in the process of calculating determinants. 9. Use of the Sarrus formula. 10. Determining the inverse matrix. 11. Solving systems of Cramer equations with the determinative method and the inverse matrix. 12. Determining the order of the matrix. 13. The use of the Kronecker - Capelli theorem to solve systems of linear equations. 14. Solving systems of equations using the Gaussian elimination method. 15. Study of the properties of conical curves. 16. Calculation of the scalar, vector and mixed product of vectors. 17. Determination of the plane equation in general, sectional and parametric form. 18. Determining the equation of a straight line in parametric, directional and edge form. 19. Solving tasks regarding the mutual position of simple points and planes in space. 20. Determination of equations of rotating, cylindrical and conical surfaces. 21. Identification of areas described by the second degree equations.
Evaluation methods	**Lecture:** Exam, Credit is granted based on sum of points obtained from practicals and an exam. **Practicals:** tests and work during classes.
Ways of verifying learning outcomes	See **TABLE No 1**
Exam	Yes
D. Student's contribution	
Number of ECTS points	4
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours- 49, including: a) lecture - 30 h.; b) practicals – 15 h c) consultations - 4 h 2) Student's individual work 51 hours, including: a)30 h – student's current preparation for practicals and lectures, literature study, b) 10 h – student's current preparation for tests, c) 11 h - student's current preparation for exam 3) TOTAL – sum of individual work and contact hours- 100 h.

Number of ECTS points for classes requiring direct participation of members of academic staff:	1,96 ECTS points – number of contact hours - 49, including: a) lecture - 30 h.; b) practicals – 15 h c) consultations - 4 h
Number of ECTS points obtained by a student within practical classes:	
E. Additional information	
Comments	

TABLE No 1. SUBJECT OUTCOMES	
Knowledge	
Outcome:	The student knows the definitions and theorems in the field of linear algebra.
Code:	1120-MT000-ISA-0102_W1
Verification:	Obtaining the required by the regulations to pass the subject the number of points for activity in the class, test 1 and the exam.
Connected field of study outcomes:	K_W01
Outcome:	The student has knowledge of analytic geometry including descriptions of straight lines, planes, conic curves and the surface of the second degree in three-dimensional space.
Code:	1120-MT000-ISA-0102_W02
Verification:	Obtaining the required by the regulations to pass the subject the number of points for activity in the class, test 2 and the exam.
Connected field of study outcome:	K_W01
Skills	
Outcome:	The student is able to perform actions in the body of complex numbers, perform operations on matrices and solve systems of linear equations.
Code:	1120-MT000-ISA-0102_U01
Verification:	Obtaining the required by the regulations to pass the subject the number of points for activity in the class, test 1 and the exam.
Connected field of study outcome:	K_U01
Outcome:	The student is able to perform actions on vectors, solve tasks regarding the mutual placement of planes, straight lines and surfaces of the second degree in three-dimensional space.
Code:	1120-MT000-ISA-0102_U02
Verification:	Obtaining the required by the regulations to pass the subject the number of points for activity in the class, test 2 and the exam.
Connected field of study outcome:	K_U01

Description of a Subject	
SUBJECT: ANALYSIS I	
Subject code	1120-00000-ISA-0101
Subject version	Version I
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery
Profile of study	General academic
Degree program	

Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Mathematics and Information Science	
B. General characteristics of the subject		
Subject kind	Basic	
Subject group	Mathematics	
Subject level	Basic	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	I	
Pre-requisites		
Limit of number of students	According to University Regulations	
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Understanding methods and concepts of differential and integral calculus of functions of one variable necessary for studying Analysis2, Differential Equations and major subjects.	
Learning outcomes	See **TABLE No 2**	
Form of classes and their duration	Lecture	30
	Practicals	30
	Laboratory	
	Project	
Learning content	Lecture: • Limits of sequences and functions: definitions, properties, applications. • Derivatives: definition, properties, applications: differential, tangent line, Taylor formula, de l'Hospital Rule, investigation of monotonicity, local and global extrema, convexity, asymptote. • Indefinite Integral: definition, properties, integration by substitution, by parts, applications • Riemann Integral: definition, properties, applications: evaluation of area, volume, length of curves. • Improper Integral: definition, properties, applications. Practicals: • Evaluating limits of sequences and functions, understanding of indefinite symbol, • Derivatives: evaluation, chain rule, differential, tangent line, Taylor formula, de l'Hospital Rule, investigation of monotonicity, local and global extrema, convexity, asymptotes, plotting graphs of functions.. • Indefinite Integral: evaluation, integration by substitution, by parts, functions: rational, trygonometric, roots, exponential • Riemann Integral: evaluation of integral, evaluation of area, volume, length of curves. • Improper Integral: evaluation, checking of convergence.	
Evaluation methods	**Lecture:** Exam, Credit is granted based on sum of points obtained from practicals and an exam. **Practicals:** Tests and work during classes.	
Ways of verifying learning outcomes	See **TABLE No 2**	
Exam	Yes	
D. Student's contribution		
Number of ECTS points	5	
Number of hours of student's work connected with achieving	1) Number of contact hours- 64, including: a) lecture - 30 h.;	

learning outcomes:	b) practicals – 30 h c) consultations - 4 h 2) Student's individual work 61 hours, including: a) 30 h – student's current preparation for practicals and lectures, literature study, b) 20 h – student's current preparation for tests, c) 11 h - student's current preparation for exam 3) TOTAL – sum of individual work and contact hours- 125 h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	2,56 ECTS points – number of contact hours - 64, including: a) lecture - 30 h.; b) practicals – 30 h c) consultations - 4 h
Number of ECTS points obtained by a student within practical classes:	
E. Additional information	
Comments	

TABLE No 2. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Knowledge of the boundaries of sequences and functions of one variable and their properties
Code:	1120-MT000-ISA-0101_W01
Verification:	Obtaining the right number of points on the tests, exam, student's work on the practicals.
Connected field of study outcomes:	K_W01, K_W03
Outcome:	Knowledge of the derivative of the function of one variable and its properties.
Code:	1120-MT000-ISA-0101_W02
Verification:	Obtaining the right number of points on the tests, exam, student's work on the practicals.
Connected field of study outcome:	K_W01, K_W03
Outcome:	Knowledge of an indefinite integral, Riemann and the wrong one and their properties.
Code:	1120-MT000-ISA-0101_W03
Verification:	Obtaining the right number of points on the tests, exam, student's work on the practicals.
Connected field of study outcome:	K_W01, K_W03
Skills	
Outcome:	Student is able to calculate the limits of sequences and functions of one variable, distinguishes between unmarked and marked symbols, and can transform indeterminate symbols. He is able to study the continuity of functions.
Code:	1120-MT000-ISA-0101_U01
Verification:	Obtaining the right number of points on the tests, exam, student's work on the practicals.
Connected field of study outcome:	K_U01
Outcome:	The student is able to calculate derivatives of the functions of one variable, he can apply the De'lHospital rule to border boundaries, he can study monotonicity and the course of function variability.
Code:	1120-MT000-ISA-0101_U02

Verification:	Obtaining the right number of points on the tests, exam, student's work on the practicals.
Connected field of study outcome:	K_U01
Outcome:	Student is able to calculate the limits of sequences and functions of one variable, distinguishes between unmarked and marked symbols, and can transform indeterminate symbols.
Code:	1120-MT000-ISA-0101_U03
Verification:	Obtaining the right number of points on the tests, exam, student's work on the practicals.
Connected field of study outcome:	K_U01
Outcome:	Student is able to calculate integrals that are not marked in particular with rational and trigonometric functions. He can calculate the Riemann integral. He can use the Riemann integral to calculate the surface area, the length of the curve and the volume of the rotary body.
Code:	1120-MT000-ISA-0101_U04
Verification:	Obtaining the right number of points on the tests, exam, student's work on the practicals.
Connected field of study outcome:	K_U01
Social competences	
Outcome:	The student is aware of his qualifications in certain areas and their lack in others. Understands the need for systematic work on your development. He works in a group to solve problems more effectively.
Code:	1150-MT000-ISA-0101_K01
Verification:	Contact with the student during the lecture and practicals
Connected field of study outcome:	K_K01

Description of a Subject	
SUBJECT: BASICS OF ENGINEERING DRAWING AND DESCRIPTIVE GEOMETRY I	
Subject code	1150-MT000-ISA-0103
Subject version	Version I
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery
Profile of study	General academic
Degree program	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering
Performing unit	Faculty of Automotive and Construction Machinery Engineering
B. General characteristics of the subject	
Subject kind	Connected with the field of study
Subject group	Basics of engineering drawing
Subject level	Basic
Subject status	Compulsory
Language of instruction	English
Nominal semester	I

Pre-requisites		
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	The aim of the course is to acquire the ability to represent graphicaly 3D elements on a drawing sheet. In the first part, concerning Descriptive Geometry, the student acquaints himself with general methods of orthographic projection, with spatial elements such as simple points and planes being considered at this stage. In the second part of the didactic process students of the course acquire the skills of technical drawing of simple machine parts, ie shafts, sleeves, bodies, gears, springs, etc.	
Learning outcomes	See **TABLE No 3**	
Form of classes and their duration	Lecture	30
	Practicals	
	Laboratory	
	Project	15
Learning content	Lecture: • Principles and methods of projection. Projections of points, lines and planes. • The relative position of the elements of space. Basic constructions. • Basics relates: point on a line; point and a line on a plane. • Common elements: a common point of two lines, line and plane, two planes edge. • Parallel elements: straight and parallel planes, a line parallel to the plane. • Orthogonal components: straight and perpendicular planes, line perpendicular to a plane. • Determination of true lengths in a space. • Construction of rabatment of lines: rabatment of a line. • Finding an Edge view of a lamina (inclined and oblique). • Surfaces: Surface projections, a point on a surface. • Points Breakdown and Cutsolids - conics. • The penetration of surfaces: the method of planes, spheres method. • Elements of Record of Design. • Principles of drawing the basic elements of and geometric constructions. • Methods of mapping objects. • Views and cross-sections in orthogonal projections. • Dimensioning of elements. • Determination of the state of the surface of objects. • Determination of tolerances and fits. • Drawing of components and connections of machine parts. • Drawing of permanrnt fastenings. • Drawing of drives elements. • Drawing of axes, shafts, bearings, seals, clutches and brakes. • Basic rules for the assembly drawings. • Mechanical schemes of components and connections. • The use of computer techniques in the preparation, recording and archiving drawings. Project: • Basics relates. • Common elements. • Parallel and perpendicular elements. • Rabatment of lines and planes. • Penetration of surfaces.	

Evaluation methods	The lecture is counted on the basis of a test. Project are counted on the basis of two tests
Ways of verifying learning outcomes	See **TABLE No 3**
Exam	No
D. Student's contribution	
Number of ECTS points	4
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours- 49, including: a) lecture – 30 h; b) project - 15 h.; c) consultations - 4 h. 2) Student's individual work 51 hours, including: a)26 h – student's current preparation for practicals, literature study, b) 25 h – student's current preparation for test. 3) TOTAL – sum of individual work and contact hours- 100.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,96 ECTS points – number of contact hours - 49, including: a) lecture – 30 h; b) project - 15 h.; c) consultations - 4 h.
Number of ECTS points obtained by a student within practical classes:	1,8 ECTS points 1) participation in project classes - 15 h. 2) 20 hours of individual work on preparing for project classes and doing individual tasks.
E. Additional information	
Comments	

TABLE No 3. SUBJECT OUTCOMES	
Knowledge	
Outcome:	A student knows the historical outline of the development of technical drawing, general principles of the construction record and the basic criteria for creating names and classification of mapped objects.
Code:	1150-MT000-ISA-0103_W1
Verification:	Written and / or oral test
Connected field of study outcomes:	K_W08
Outcome:	A student knows the methods of mapping objects, axonometric projection methods and the European projection system; knows the principles of drawing axonometric drawings based on orthogonal projections and vice versa;
Code:	1150-MT000-ISA-0103_W2
Verification:	Written and / or oral test
Connected field of study outcome:	K_W07, K_W08
Outcome:	A student knows the principles of drawing and dimensioning simple and complex elements of machines and structures, knows the ordinal general and special rules for the dimensioning of machine elements and structures;
Code:	1150-MT000-ISA-0103_W3
Verification:	Written and / or oral test
Connected field of study outcome:	K_W08, K_W11

Outcome:	A student has knowledge about the representation and dimensioning of connectors and separable and inseparable connections
Code:	1150-MT000-ISA-0103_W4
Verification:	Written test
Connected field of study outcome:	K_W07
Skills	
Outcome:	A student can use methods of mapping objects, axonometric projection methods and the European projection system; can make an axonometric drawing based on orthogonal projections and vice versa; is able to map machine elements in the form of views and partial views, cross-sections and partial cross-sections, view pits and local elevations and elevated cross-sections, knows how to apply normalized hatch rules for cross-sections.
Code:	1150-MT000-ISA-0103_U1
Verification:	Evaluation of a student's individual project realization .
Connected field of study outcome:	K_U21,
Outcome:	A student can draw and dimension simple and complex elements of machines and constructions, he knows and applies in practice the ordinal general and special principles of dimensioning of machine elements and structures
Code:	1150-MT000-ISA-0103_U2
Verification:	Evaluation of a student's individual project realization .
Connected field of study outcome:	K_U21,
Outcome:	A student can represent and dimension connectors and detachable and inseparable connections
Code:	1150-MT000-ISA-0103_U3
Verification:	Evaluation of a student's individual project realization .
Connected field of study outcome:	K_U21,
Social competences	
Outcome:	A student can represent and dimension connectors and detachable and inseparable connections
Code:	1150-MT000-ISA-0103_K1
Verification:	Evaluation of a student's individual project realization and group discussion.
Connected field of study outcome:	K_K03, K_K04.

Description of a Subject	
SUBJECT: STRUCTURAL MATERIALS	
Subject code	1150-MT000-ISA-0104
Subject version	Version I
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery

Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Structural materials	
Subject level	Basic	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	I	
Pre-requisites		
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	The aim of the course is to provide the knowledge and understanding of the relationship between composition, structure, properties (mainly mechanical) and applications of different groups of structural materials, like metals and their alloys, ceramics, polymers and composite materials. The basic knowledge on crystalline structure and its defects, methods of measurements of mechanical properties and their enhancement by plastic deformation, thermal treatment and surface engineering will also be presented.	
Learning outcomes	See **TABLE No 4**	
Form of classes and their duration	Lecture	45
	Practicals	
	Laboratory	
	Project	
Learning content	Lecture: [L1] - Introduction to materials science. Structure of metals and alloys, crystalline and amorphous materials, introduction to crystallography, polymorphism, anisotropy of crystalline materials, defects of crystalline structure and their influence on alloys properties. Types of solid solutions and intermetallic compounds. [L2] – Mechanical properties of structural materials, density, stiffness, elasticity, static strength, fatigue strength, hardness, toughness, brittleness, abrasion resistance, creep strength. [L3] – Phase equilibria, Gibb's rule, solid state phase transformations during slow heating or cooling of various two-component alloys, mechanism and kinetics of phase transformations. [L4] – Methods of materials strengthening – by solid solution formation, dispersion strengthening, by grain refinement, by plastic deformation, curing and recrystallization processes. [L5] - Fe–C alloys. Mechanical properties of iron, allotropy of crystalline iron, phase equilibrium of Fe-C system, eutectoid transformation, structural phase equilibrium of Fe–Fe3C system, phase transformations for Fe – C alloys and their influence on structure and properties of steels. [L6] - Influence of carbon and alloying elements on structure and properties of Fe-C alloys. Heat treatment of Fe-C alloys. [L7] - Industrial iron alloys - classification, selection criteria, properties and application examples of industrial steel (structural, machine, tool, spring, corrosion resistant and heat-resistant steels). [L8] - Test No 1. [L9] - Aluminium and aluminium-based alloys – properties, methods of strengthening, classification of Al-based alloys, properties and application of Al alloys. [L10] - Copper and Cubased alloys. Properties, designation, structure and application of Cu-based alloys (brass, bronze, other). [L11] - Structure, properties and application of ceramics. Types of engineering ceramics, fabrication, microstructure, relationship between microstructure and properties of ceramics working under stress, rules of used ceramics as constructional materials, ceramics for special applications. [L12] - Structure, properties and application of polymers – classification of polymers,	

	constitution of macromolecules, structure of polymers and their influence on the properties and strain mechanisms of polymers, characteristic of elastomers and plastomers, application of polymers in automotive industry, types of plastics, marking method. [L13] -Structure, properties and application of composites - composite's classification, fibre reinforced composites, properties of fibre reinforced composites, composite's constituents and their effect on polymer matrix composites reinforced with fibres, particle reinforced composites. [L14] - Surface Engineering – Essence of surface engineering, description: coating, layer, surface layer, the surface engineering techniques, an overview of modern methods of surface engineering: glow discharge methods, CVD and PVD processes, ion implantation, laser treatments, structure and properties of the surface layers, examples of applications, multiplex techniques taking into account the thermal and detonation spray processes, and also chemical and electrochemical treatments, formation the properties of structural and functional materials by surface engineering techniques, examples for the automotive industry. [L15] - Test No 2.
Evaluation methods	Two tests: test no 1 at the 8th lecture, checking the knowledge presented during the first seven lectures and test no 2 at the 15th lecture (the last lecture) to check the knowledge presented at lectures L9-L14.
Ways of verifying learning outcomes	See **TABLE No 4**
Exam	No
D. Student's contribution	
Number of ECTS points	3
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours- 48, including: a) lecture – 45 h; b) consultations - 3 h. 2) Student's individual work 27 hours, including: a)12 h – student's current preparation for lectures, literature study, b) 15 h – student's current preparation for test. 3) TOTAL – sum of individual work and contact hours- 75.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,92 ECTS points – number of contact hours - 48, including: a) lecture – 45 h; b) consultations - 3 h.
Number of ECTS points obtained by a student within practical classes:	
E. Additional information	
Comments	

TABLE No 4. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Has basic knowledge in materials mechanics, including stress, strain and methods of mechanical properties measurements of ductile and brittle materials necessary to conduct strength analysis.
Code:	1150-MT000-ISP-0104_W1
Verification:	Two written tests
Connected field of study outcomes:	K_W04
Outcome:	Has basic knowledge on the influence of different materials on the lifetime of vehicles and the problem of recycling and also on the impact of different groups of materials on the

	environment.
Code:	1150-MT000-ISP-0104_W2
Verification:	Two written tests
Connected field of study outcome:	K_W09
Skills	
Outcome:	Can find appropriate information on materials from literature, data bases and other sources; is able to evaluate their usefulness taking into account properties and their stability, price and recycling aspects.
Code:	1150-MT000-ISP-0104_U1
Verification:	Two written tests
Connected field of study outcome:	K_U01,
Outcome:	Is able to judge critically different options of materials selected for the design of project elements taking into account utility and econoomical criteria.
Code:	1150-MT000-ISP-0104_U2
Verification:	Two written tests
Connected field of study outcome:	K_U09,
Social competences	
Outcome:	Is aware of the importance of materials selection on the non-technical aspects and effects of mechanical engineer activity.
Code:	1150-MT000-ISP-0104_K1
Verification:	Tests.
Connected field of study outcome:	K_K02
Outcome:	Is able to think critically and to act practically
Code:	1150-MT000-ISP-0104_K1
Verification:	Discussions during lectures and tests.
Connected field of study outcome:	K_K05

Description of a Subject	
SUBJECT: COMPUTER TECHNIQUES I	
Subject code	1150-00000-ISA-0105
Subject version	Version I
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery
Profile of study	General academic
Degree program	

Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Informatics	
Subject level	Basic	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	I	
Pre-requisites	None	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Basic computer techniques (methods and tools) in mechanical engineering.	
Learning outcomes	See **TABLE No 5**	
Form of classes and their duration	Lecture	30
	Practicals	
	Laboratory	30
	Project	
Learning content	Lecture (semester I): 1. Fundamental features of algorithms. Forms of algorithms. Elementary examples. Variables. Data types and their representations. Arithmetic operators. Relational and logical operators. Functions. If statement. Basic algorithms. 2. Loop instructions. Function and structure of program. Basic algorithms. 3. Arrays and pointers. 4. Algorithms of simulation, algorithms of generation. 5. Files. Operations input/output. Algorithms based on geometric operations. 6. Structures. Data structures. Lists. Algorithms for selection problems. 7. Introduction to computer engineering. Characteristics of CAD systems. Geometric modeling. 8. Characteristics of CAE systems. Engineering problems' modeling. Test I. 9. History of computer techniques. Elements of information theory, computer systems, operating systems. 10. Mathematical algorithms. Numerical algorithms. 11. Algorithms for sorting. Algorithms based on iterations. 12. Data bases, fundamental concepts. 13. Data bases, process of development. 14. Object oriented programming, fundamentals. Declarative languages, basic concepts. Test II. 15. Resit. (programming language: C) Laboratory (semester I): 1. Overview of the environment, the construction of the elementary program. Function main. Input and output statements. 2. Creating numerical algorithms, 3. Creating Algorithms of conditional statements. Logical operators, size of operator 4. Creating Algorithms of instructions cycle while , instructions cycle for, , instructions cycle do ... while, Generate algorithms, Iterative algorithms. 5. Arithmetic calculations. Constants const, typdef statement, priorities and communications operators and type conversions (casting), mathematical functions, mathematical constants cmath library. Generate random numbers. The switch statement, nested loops, break and continue statements, goto information (not recommended!). Generating algorithms. Selection algorithms. 6. Declarations and definitions of functions, function parameters, the arguments alleged. Global variables, variable automatic (local), local variables static , namespaces , global static names (range between files) , Recursion . Iterative algorithms . hashing algorithms 7. Dimensional arrays and multidimensional arrays, arrays as functions parameter . Sorting Algorithms . Algorithms for task selection . Iterative algorithms 8. Pointers. Pointers as function parameter. Dynamic memory allocation : operators new, delete . Iterative algorithms . 9. The structures, unions and bit fields . Selection Algorithms. 10. Data Structures list , stack , queue , tree . Sorting Algorithms . Iterative algorithms . 11. Reading and writing files. Numerical algorithms 12. Understanding the Windows Form, the concept of object properties, methods . Building form applications TextBox	

	, Button . Software event handler. 13.Vector graphics. Simulation Algorithms . geometric algorithms 14-15.Correction class. (programming language: C)
Evaluation methods	tests
Ways of verifying learning outcomes	See **TABLE No 5**
Exam	No
D. Student's contribution	
Number of ECTS points	5
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours - 65, including; a) lecture - 30 h; b) laboratory- 30 h; c) consultations – 5 h. 2) Student's individual work - 60 h, including: a) 10 h – literature study; b) 30 h – preparation for classes and laboratories; c) 10 h – preparing reports; d) 10 h – preparing for tests; 3) TOTAL – 125.
Number of ECTS points for classes requiring direct participation of members of academic staff:	2.6 ECTS points – number of contact hours - 65, including: a) lecture - 30 h; b) laboratory- 30 h; c) consultations – 5 h.
Number of ECTS points obtained by a student within practical classes:	2.6 ECTS points – number of contact hours - 65, including: a) laboratory- 30 h; b) consultations – 5 h. c) preparation for classes and laboratories - 30 h;
E. Additional information	
Comments	

TABLE No 5. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Has basic knowledge on history of computer methods development
Code:	1150-00000-ISA-0105_W1
Verification:	written tests
Connected field of study outcomes:	K_W07, K_W08.
Outcome:	Has basic knowledge on computer support of engineering activities.
Code:	1150-00000-ISA-0105_W2
Verification:	written test
Connected field of study outcomes:	K_W07, K_W08.
Outcome:	Has basic knowledge on algorithmic programming.
Code:	1150-00000-ISA-0105_W3
Verification:	written test
Connected field of study outcomes:	K_W01, K_W07
Outcome:	Has basic knowledge on database approach, expert systems and object oriented modeling.
Code:	1150-00000-ISA-0105_W4

Verification:	written test
Connected field of study outcomes:	K_W01, K_W07
Skills	
Outcome:	Will be able to build basic computer programs based on algorithmic programming.
Code:	1150-00000-ISA-0105_U1
Verification:	Test-exercise
Connected field of study outcome:	K_U10,
Social competences	
Outcome:	Will be able to work individually and in a team
Code:	1150-00000-ISA-0105_K1
Verification:	Test-exercise
Connected field of study outcome:	K_K04

Description of a Subject	
SUBJECT: ENVIRONMENTAL PROTECTION	
Subject code	1150-00000-ISA-0107
Subject version	Version I
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery
Profile of study	General academic
Degree program	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering
Performing unit	Faculty of Automotive and Construction Machinery Engineering
B. General characteristics of the subject	
Subject kind	Connected with the field of study
Subject group	Environmental Protection
Subject level	Basic
Subject status	Compulsory
Language of instruction	English
Nominal semester	I
Pre-requisites	Basic knowledge in the field of biology, physics and chemistry (secondary school program).
Limit of number of students	
C. Learning outcomes and the manner of conducting classes	
Aim of the subject	Fundamental knowledge in environmental protection used for technical processes analysis. Understanding the methods applied in the automotive industry focused on reducing its harmful impact on the environment. Acquiring the ability to use obtained knowledge related to the interaction between civilization and environment. Development of student's awareness of global threats to the environment and the principles of sustainable development in human civilization.

Learning outcomes	See **TABLE No 7**	
Form of classes and their duration	Lecture	30
	Practicals	
	Laboratory	
	Project	
Learning content	Lecture: 1. Introduction. 1.1 Basic concepts. 1.2 Criteria for harmful impacts on the environment. 2. Human environment. 2.1 Earth and ecosystems. 2.2 Global biogeochemical cycles. 3. Natural and environmental hazards of civilization. 4. Actions to protect the environment. 5. Protection of the environment from the motorization. 6. Conclusion.	
Evaluation methods	Two tests	
Ways of verifying learning outcomes	See **TABLE No 7**	
Exam	No	
D. Student's contribution		
Number of ECTS points	2	
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours- 32, including: a) lecture – 30 h; b) consultations - 2 h. 2) Student's individual work 20 hours, including: a)10 h – student's current preparation for lectures, literature study, b) 10 h – student's current preparation for test. 3) TOTAL – sum of individual work and contact hours- 52.	
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,28 ECTS points – number of contact hours - 32, including: a) lecture – 30 h; b) consultations - 2 h.	
Number of ECTS points obtained by a student within practical classes:		
E. Additional information		
Comments		

TABLE No 7. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Acquiring detailed knowledge on environmental hazards resulting from the motor vehicles usage
Code:	1150-00000-ISA-0107_W1
Verification:	Two written tests
Connected field of study outcomes:	K_W09, K_W20, K_W21
Outcome:	Acquired basic knowledge on environmental protection useful for assessing the impact of technical solutions on the environment.
Code:	1150-00000-ISA-0107_W2
Verification:	Two written tests

Connected field of study outcome:	K_W09, K_W20, K_W21
Skills	
Outcome:	Is prepared to obtain information from literature and other properly selected sources within the subject area; ability to integrate the information obtained, interpret it, draw conclusions, and formulate and justify opinions on environmental protection.
Code:	1150-00000-ISA-0107_U1
Verification:	Two written tests
Connected field of study outcome:	K_U01,
Outcome:	Gained the ability to acquire knowledge on environmental issues independently.
Code:	1150-00000-ISA-0107_U2
Verification:	Two written tests
Connected field of study outcome:	K_U01,
Social competences	
Outcome:	A clear understanding the importance of undertaking engineering activities to reduce the impact of motorization on the environment.
Code:	1150-00000-ISA-0107_K1
Verification:	Tests.
Connected field of study outcome:	K_K02

Description of a Subject	
SUBJECT: CHEMISTRY	
Subject code	1150-00000-ISA-0109
Subject version	Version I
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery
Profile of study	General academic
Degree program	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering
Performing unit	Faculty of Automotive and Construction Machinery Engineering
B. General characteristics of the subject	
Subject kind	Connected with the field of study
Subject group	Chemistry
Subject level	Basic
Subject status	Compulsory
Language of instruction	English
Nominal semester	I
Pre-requisites	None
Limit of number of students	
C. Learning outcomes and the manner of conducting classes	

Aim of the subject	After completion of the course student should have acquired: - basic knowledge of inorganic chemistry, physical chemistry, organic chemistry and chemical technology; - ability to describe and explain basic concepts of transformations and chemical phenomena; - ability to solve simple chemical calculation problems; - ability to gather data and information from literature in the field, assess their credibility, interpret them and form logical conclusions.	
Learning outcomes	See **TABLE No 9**	
Form of classes and their duration	Lecture	30
	Practicals	
	Laboratory	
	Project	
Learning content	The aim of the lecture is to familiarize students with the basic concepts of the main chemistry fields connected to structure of matter and its chemical aspect: I. General Chemistry: basic atomistic theories, atom bonds theory and element classification, fundamental chemical concepts and laws, types of chemical reactions, chemistry of aqueous solutions, inorganic compounds types and their characteristic reactions. II. Physical chemistry: reaction kinetics and equilibria, factors influencing chemical reaction rate, reaction types in terms of kinetics, role of catalyst, chemical thermodynamics basis, most important state functions and three laws of thermodynamics, key concepts of termochemistry. III. Electrochemistry: electrolytical dissociation, galvanic cells and electrolysis. IV. Organic chemistry: classification of organic compounds, their functional groups, their synthesis methods and reactions. Along with the review of specific organic compound classes, analytical and separation methods as well as connected phenomena will be presented. V. Industrial processes: Chosen industrial processes with particular focus on crude oil processing, combustion processes (power engineering). In the course of the lectures students will learn basics of chemical calculations as well as solving easy problems based on the present lecture's topic.	
Evaluation methods	Test	
Ways of verifying learning outcomes	See **TABLE No 9**	
Exam	No	
D. Student's contribution		
Number of ECTS points	2	
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours- 32, including: a) lecture – 30 h; b) consultation – 2 h; 2) Student's individual work 20 hours, including: a)10 h – student's current preparation for lectures, literature study, b) 20 h – student's current preparation for test. 3) TOTAL – sum of individual work and contact hours- 62.	
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,28 ECTS points – number of contact hours - 32, including: a) lecture – 30 h; b) consultation – 2 h;	
Number of ECTS points obtained by a student within practical classes:		
E. Additional information		
Comments		

TABLE No 9. SUBJECT OUTCOMES

Knowledge	
Outcome:	The student has basic knowledge of inorganic, physical, organic chemistry and chemistry technology.
Code:	1150-00000-ISA-0109_W1
Verification:	Written tests
Connected field of study outcomes:	K_W02
Skills	
Outcome:	The student can describe the basic concepts of chemical changes and phenomena
Code:	1150-00000-ISA-0109_U1
Verification:	Written tests
Connected field of study outcome:	K_U02,
Outcome:	The student can solve simple computational tasks from the known branches of chemistry.
Code:	1150-00000-ISA-0109_U2
Verification:	Written tests
Connected field of study outcome:	K_U02,
Outcome:	The student is able to obtain information from the literature and interpret it, evaluate their reliability and draw conclusions from them..
Code:	1150-00000-ISA-0109_U3
Verification:	Written tests
Connected field of study outcome:	K_U19,

Description of a Subject	
SUBJECT: PHYSICS I	
Subject code	1150-00000-ISA-0110
Subject version	Version I
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery
Profile of study	General academic
Degree program	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering
Performing unit	Faculty of Automotive and Construction Machinery Engineering
B. General characteristics of the subject	
Subject kind	Connected with the field of study
Subject group	Physics
Subject level	Basic
Subject status	Compulsory
Language of instruction	English
Nominal semester	I
Pre-requisites	None
Limit of number of	

students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	The aim of the lecture is to provide students with basic knowledge about the general principles of physics, physical quantities, fundamental interactions and their physical and mathematical description. After completing the course the student should have ordered knowledge in the field of non-relativistic mechanics, hydrostatics, hydrodynamics of phenomenological thermodynamics.	
Learning outcomes	See **TABLE No 10**	
Form of classes and their duration	Lecture	30
	Practicals	
	Laboratory	
	Project	
Learning content	(1) Introduction; physical quantities, SI units, coordinate system, calculations with vectors and units, estimates and oders of magnitude (2) Motion along a straight line and in two or three dimentions. Displacement, distance, velocity, acceleration. (3) Newton's laws of motion. Momentum and impulse. Work and energy. Definition and calculation of work. (4) Gravitational and elastic potential energy. Kinetic energy. Conservation of energy and momentum in mechanics. (5) Rotation of rigid bodies. Relating linear and angular kinematics. Energy in rotational motion. Dynamics of rotational motion, conservation of angular momentum. Kepler's laws of planetary motion. (6) Hydrostatics; density and pressure. Pascal's law, hydraulic systems. Buoyancy. (7) Hydrodynamics; fluid flow, continuity equation and Bernoulli's equation. The properties of real fluids - viscosity and turbulence, dynamic resistance and coefficient of resistance, the Magnus effect. (8) Thermodynamics; Kinetic theory of gases. Temperature, heat, laws of thermodynamics. Basic thermodynamic processes. Equations of state. Heat engines. Entropy . (9) Heat transfer, thermal resistance. Thermal expansion of solids and liquids.	
Evaluation methods	Exam	
Ways of verifying learning outcomes	See **TABLE No 10**	
Exam	Yes	
D. Student's contribution		
Number of ECTS points	2	
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours- 32, including: a) lecture – 30 h; b) consultation – 2h; 2) Student's individual work 20 hours, including: a)20 h – student's current preparation for lectures, literature study, b) 10 h – student's current preparation for test. 3) TOTAL – sum of individual work and contact hours- 62.	
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,28 ECTS points – number of contact hours - 32, including: a) lecture – 30 h; b) consultation – 2h;	
Number of ECTS points obtained by a student within practical classes:		
E. Additional information		

Comments	

TABLE No 10. SUBJECT OUTCOMES	
Knowledge	
Outcome:	• has a basic knowledge of the general principles of physics, physical quantities, fundamental interactions, • has structured knowledge in the field of non-relativistic mechanics, including kinematics, principles of dynamics Newton's concept of the equation of motion, conservative and non-conservative forces, kinetic and potential energy, principles of conservation of momentum, energy has basic knowledge in the field of hydrostatics, including the concept of pressure, Pascal and Archimedes' laws, and hydrodynamics, including Bernouli's law. • has ordered knowledge in the field of phenomenological thermodynamics, including the first and second principles of thermodynamics, the concept of the equation of state of perfect and real gas, internal energy, reversible and irreversible processes, the concept of entropy; has ordered knowledge in the field of classical statistical thermodynamics, covering the experimental basis of kinetic-molecular theory of matter construction, basic the concepts of physical statistics, statistical interpretation of entropy, the principle of equipartition of energy, statistical distributions, diffusion phenomena and thermal conductivity.
Code:	1150-00000-ISA-0110_W1
Verification:	written exam
Connected field of study outcomes:	K_W02, K_W03
Skills	
Outcome:	The student can solve tasks in the field of non-relativistic mechanics, hydrostatics, thermodynamics.
Code:	1150-00000-ISA-0110_U1
Verification:	written exam
Connected field of study outcome:	K_U01,

Description of a Subject	
SUBJECT: ANALYSIS II	
Subject code	1150-00000-ISA-0114
Subject version	Version I
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery
Profile of study	General academic
Degree program	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering
Performing unit	Faculty of Automotive and Construction Machinery Engineering
B. General characteristics of the subject	
Subject kind	Connected with the field of study
Subject group	Compulsory
Subject level	Basic
Subject status	Compulsory
Language of instruction	English

Nominal semester	2	
Pre-requisites	Knowledge of the notions and methods of the differential and integral calculus of functions of one variable (Analysis I), matrix and analytic geometry (Algebra)	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Understanding the methods and concepts of the differential and integral calculus of functions of many variables and elements of the field theory necessary for studying directional subjects.	
Learning outcomes	See **TABLE No 11**	
Form of classes and their duration	Lecture	30
	Practicals	30
	Laboratory	
	Project	
Learning content	Vector spaces, linear transformations, base, transformation matrix, rotation matrix. Norm, boundaries of sequences in normed spaces. Functions in normed spaces, function limits, continuity. Directional, partial derivative. Derivative as a linear transformation, gradient, complete differential. Derivative of a two-linear transformation, a complex function. Multi-line forms (tensors), two-liner matrix, square form, square form sign. Higher order derivative: partial derivatives, multilinear transformation. Taylor's formula, local extrema, a necessary and sufficient condition. Entangled function, smooth hyper surface. Conditional extremes, Lagrange multipliers, global extremes. Jordan's measure on the plane, double integral - definition, calculation. Substitution: linear, polar coordinates. Double integral incorrect. Application of double integral. Jordan's measure in space, triple integral - definition, calculation. Substitution: linear, cylindrical, spherical coordinates. The use of triple integral. Curvilinear integral directed and unrecorded. Surface integral oriented and unoriented. Scalar fields, vector, gradient, divergence, rotation. Potential, relation to the curved-line integral. Green, Gauss, Stokes theorem.	
Evaluation methods	**Lecture:** Exam, Credit is granted based on sum of points obtained from practicals and an exam. **Practicals:** Tests and work during classes.	
Ways of verifying learning outcomes	See **TABLE No 11**	
Exam	Yes	
D. Student's contribution		
Number of ECTS points	5	
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours- 64, including: a) lecture - 30 h.; b) practicals – 30 h c) consultations - 4 h 2) Student's individual work 61 hours, including: a) 30 h – student's current preparation for practicals and lectures, literature study,	

	b) 20 h – student's current preparation for tests, c) 11 h - student's current preparation for exam 3) TOTAL – sum of individual work and contact hours- 125 h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	2,56 ECTS points – number of contact hours - 64, including: a) lecture - 30 h.; b) practicals – 30 h; c) consultations - 4 h;
Number of ECTS points obtained by a student within practical classes:	
E. Additional information	
Comments	

TABLE No 11. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Has basic knowledge of the boundaries of sequences in vector spaces. Knowledge of the limits of functions of many variables and functions with vector values. Continuity of functions. Knowledge of derivatives of vector functions, directional derivatives, partial derivatives, derivatives as linear transformation, higher derivatives. Knowledge of their property.
Code:	1150-00000-ISA-0114_W1
Verification:	Obtaining the right number of points on the tests, exam, student's work on the practicals.
Connected field of study outcomes:	K_W01, K_W03
Outcome:	Has basic knowledge of the boundaries of sequences in vector spaces. Knowledge of the limits of functions of many variables and functions with vector values. Continuity of functions. Knowledge of local, global and conditional exotherms. Knowledge of entangled functions.
Code:	1150-00000-ISA-0114_W2
Verification:	Obtaining the right number of points on the tests, exam, student's work on the practicals.
Connected field of study outcomes:	K_W01, K_W03
Outcome:	Has basic knowledge of the boundaries of sequences in vector spaces. Knowledge of the limits of functions of many variables and functions with vector values. Continuity of functions. Knowledge of double and triple integrals, their properties and applications.
Code:	1150-00000-ISA-0114_W3
Verification:	Obtaining the right number of points on the tests, exam, student's work on the practicals.
Connected field of study outcomes:	K_W01, K_W03
Outcome:	Has basic knowledge of the boundaries of sequences in vector spaces. Knowledge of the limits of functions of many variables and functions with vector values. Continuity of functions. Knowledge of curved and surface integrals. Knowledge of their applications. Knowledge of the concept of potential. Knowledge of Green, Gauss and Stokes theorems.
Code:	1150-00000-ISA-0114_W4
Verification:	Obtaining the right number of points on the tests, exam, student's work on the practicals.
Connected field of study outcomes:	K_W01, K_W03
Skills	

Outcome:	Student is able to calculate partial derivatives of functions of several variables. He can find a complete differential and a tangent plane. He can calculate the derivative of a complex and entangled function.
Code:	1150-00000-ISA-0114_U1
Verification:	Obtaining the right number of points on the tests, exam, student's work on the practicals.
Connected field of study outcome:	K_U01,K_U03
Outcome:	He can find local, conditional, global extremes and entangled functions. The student can calculate the double integrals by converting them into an iterated integral. He can use polar coordinates. Is able to calculate the area of flat and space, volume of a solid, static moment, inertia and the center of gravity of a flat area.
Code:	1150-00000-ISA-0114_U2
Verification:	Obtaining the right number of points on the tests, exam, student's work on the practicals.
Connected field of study outcome:	K_U01,K_U03
Outcome:	The student is able to calculate triple integrals by converting them into an iterated integral. He can apply cylindrical and spherical coordinates. He can calculate the volume of the solid, the static moment, the inertia and the center of gravity of the solid.
Code:	1150-00000-ISA-0114_U3
Verification:	Obtaining the right number of points on the tests, exam, student's work on the practicals.
Connected field of study outcome:	K_U01,K_U03
Outcome:	The student knows how to calculate the curved integral and unskinful integrals, converting them into integrals of the function of one variable. Can calculate the length of the curve, static moment, inertia and the center of gravity of the curve, work in the field of forces. .
Code:	1150-00000-ISA-0114_U4
Verification:	Obtaining the right number of points on the tests, exam, student's work on the practicals.
Connected field of study outcome:	K_U01,K_U03
Outcome:	Student is able to calculate surface integrals oriented and unoriented, converting them into double integrals. He can calculate the surface area in space, the static moment, the inertia and the center of gravity of the surface, the strings of the vector field. . The student knows how to apply Green, Gauss and Stokes theorems.
Code:	1150-00000-ISA-0114_U5
Verification:	Obtaining the right number of points on the tests, exam, student's work on the practicals.
Connected field of study outcome:	K_U01,K_U03
Social competences	
Outcome:	The student is aware of his qualifications in certain areas and their lack in others. Understands the need for systematic work on your development. He works in a group to solve problems more effectively
Code:	1150-00000-ISA-0114_K1
Verification:	Contact with the student during the lecture and exercises
Connected field of study outcome:	K_K01

Description of a Subject		
SUBJECT: DIFFERENTIAL EQUATIONS		
Subject code	1150-00000-ISA-0115	
Subject version	Version I	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Compulsory	
Subject level	Basic	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	2	
Pre-requisites	Knowledge of the differential and integral calculus of one variable function (within the scope of Analysis I program).	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Knowledge of selected branches of ordinary differential equations, the theory of numerical, functional and Fourier series, and differential geometry necessary to study major subjects.	
Learning outcomes	See **TABLE No 12**	
Form of classes and their duration	Lecture	30
	Practicals	30
	Laboratory	
	Project	
Learning content	**Lecture** 1. Ordinary differential equations Basic definitions. Classification of differential equations. General and specific solutions. Cauchy's problem for ordinary differential equations. Theorems of Peano and Picard. First order differential equations: - differential equations with separated variables, - differential equations that can be reduced to equations with separated variables, □ linear differential equations, - Bernoulli's differential equation. Differential equations of the line family. Orthogonal lines. Second order differential equations: - differential equations applied to first order equations, - linear differential equations, - heterogeneous linear differential equations with constant coefficients, the method of constant constitution and the method of predictions. Linear differential equations of order n with fixed coefficients. Systems of differential equations. 2. Numeric series Definition of the sum of the series. Necessary condition of convergence. Criteria for the convergence of series: comparative,	

	d'Alembert, Cauchy, integral, Leibniz. 3. Strings and function series The point convergence and uniform convergence of the series, Weierstrass's theorem on the convergence of a series of functions. Power series, Cauchy-Hadamard theorem, developing functions in the ranks of Taylor and Maclaurin. 4. Fourier series Definition of trigonometric series and Fourier series, Euler-Fourier patterns, Dirichlet conditions. 5. Elements of differential geometry Flat curves: - definition of a flat curve, parametric form, explicit and entangled equation of the curve, regular curve, regular curve, arc and curve orientation, □ tangent and normal vector, tangent equation, - curvature, curvature circle, - curve involute and involute curve, - a boundary of a single-parameter family of flat curves. Curves in space: - curvature and torsion of the spatial curve, - Frenet's triad. **Practicals** 1. Ordinary differential equations First order differential equations: - identification of equation types, - setting general solutions, - solving Cauchy's problem, Determination of differential equations of the family of lines and equations of orthogonal lines. Second order differential equations: - solving of import equations to first order equations, - solving linear homogeneous differential equations, - solving non-homogenous linear differential equations with constant coefficients using constant method and prediction method. Solving linear differential equations of order n with constant coefficients. Solving systems of differential equations. 2. Numerical series - testing the convergence of series. 3. Strings and function series - determining the convergence intervals of power series, developing functions in the Taylor and Maclaurin series. 4. Fourier series - determination of Fourier series. 5. Elements of differential geometry Flat curves: - determination of curve equations, - construction of the tangent and normal vector, determination of the tangent equation, - determination of curvature and curvature circle, - determination of the evolute, involute and envelope of a single-parameter family of flat curves. Curves in space: - determination of curvature and turbulence of the spatial curve, - determining the normal plane, strictly tangent and rectifying and Frenet's triad.
Evaluation methods	**Lecture:** Exam, Credit is granted based on sum of points obtained from practicals and an exam. **Practicals:** Tests and work during classes.
Ways of verifying learning outcomes	See **TABLE No 12**
Exam	Yes

D. Student's contribution	
Number of ECTS points	5
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours- 64, including: a) lecture - 30 h.; b) practicals – 30 h c) consultations - 4 h 2) Student's individual work 61 hours, including: a) 30 h – student's current preparation for practicals and lectures, literature study, b) 20 h – student's current preparation for tests, c) 11 h - student's current preparation for exam 3) TOTAL – sum of individual work and contact hours- 125 h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	2,56 ECTS points – number of contact hours - 64, including: a) lecture - 30 h.; b) practicals – 30 h; c) consultations - 4 h;
Number of ECTS points obtained by a student within practical classes:	
E. Additional information	
Comments	

TABLE No 12. SUBJECT OUTCOMES	
Knowledge	
Outcome:	The student demonstrates knowledge of classification of ordinary differential equations and techniques of solving selected types of equations.
Code:	1150-00000-ISA-0115_W1
Verification:	Obtaining the required by the regulations to pass the subject the number of points for activity in the class, colloquium 1 and the exam.
Connected field of study outcomes:	K_W01
Outcome:	The student has a basic knowledge of the theory of numeric and functional series.
Code:	1150-00000-ISA-0115_W2
Verification:	Obtaining the required by the regulations to pass the subject the number of points for activity in the class, colloquium 2 and the exam.
Connected field of study outcomes:	K_W02
Outcome:	Student ma uporządkowaną wiedzę w zakresie podstaw geometrii różniczkowej.
Code:	1150-00000-ISA-0115_W3
Verification:	Obtaining the required by the regulations to pass the subject the number of points for activity in the class, colloquium 2 and the exam.
Connected field of study outcomes:	K_W03
Skills	
Outcome:	Student is able to identify the type of differential equation and apply the appropriate method to solve it.
Code:	1150-00000-ISA-0115_U1
Verification:	Obtaining the required by the regulations to pass the subject the number of points for activity in the class, colloquium 1 and the exam.
Connected field of study outcome:	K_U01
Outcome:	The student is able to apply appropriate criteria to study the convergence of numerical series, develop functions in the Taylor and Maclaurin series and determine the Fourier series.

	The student is able to use methods of mathematical analysis to study the properties of curves, determine curvature, torsion and elements of Frenet triad.
Code:	1150-00000-ISA-0115_U2
Verification:	Obtaining the required by the regulations to pass the subject the number of points for activity in the class, colloquium 2 and the exam.
Connected field of study outcome:	K_U01

Description of a Subject		
SUBJECT: ELECTRICAL AND ELECTRONICS ENGINEERING I		
Subject code	1150-00000-ISA-0116	
Subject version	Version I	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Compulsory	
Subject level	Basic	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	2	
Pre-requisites	None	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	After completing the course the student should have a general theoretical knowledge on: - basic phenomena describing circuits DC, - basic phenomena describing magnetic circuits, - basic phenomena describing circuits AC, - basic circuits serial and parallel RLC, The student should be able to perform basic: - measurements of electrical quantities -calculations power balance for various types of electric current depending on the load.	
Learning outcomes	See **TABLE No 13**	
Form of classes and their duration	Lecture	30
	Practicals	
	Laboratory	15
	Project	
Learning content	Lecture • Basic laws for DC circuits, • Electrochemical batteries – basic laws, • Energy and power DC, • The basic laws for magnetic circuits, • The magnetic properties of materials, • Basic laws for AC circuits, • Serial RLC circuit - resonance voltage, • Parallel RLC circuit - resonance current, • The unstable in circuits RL, • The unstable in circuits RC, • Measuring instruments • Methods of measurement of electrical quantities Laboratory • Measurement of basic electrical AC and DC. • Methods for extending the measuring range in measuring circuits DC and AC. • Measurement parameters in magnetic circuits. • Power measurement circuits , single-phase and three-phase. • Energy measurement circuits , single-phase and threephase.	
Evaluation methods	2 tests, written and oral exam	

Ways of verifying learning outcomes	See **TABLE No 13**
Exam	Yes
D. Student's contribution	
Number of ECTS points	4
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours - 48, including; a) lecture - 30 h; b) laboratory- 15 h; c) consultations – 3 h. 2) Student's individual work - 52 h, including: a) 7 h – literature study; b) 30 h – preparation for classes and laboratories; c) 8 h – preparing reports; d) 7 h – preparing for tests; 3) TOTAL – 100.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,92 ECTS points – number of contact hours -48, including: a) lecture - 30 h; b) laboratory- 15 h; c) consultations – 3 h.
Number of ECTS points obtained by a student within practical classes:	1,96 ECTS points – number of contact hours - 49, including: a) laboratory- 15 h; b) consultations – 3 h. c) preparation for classes and laboratories - 30 h;
E. Additional information	
Comments	

TABLE No 13. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Having the knowledge about basic issues: describing the influence of electrical field on charge in electric field, describing magnetic phenomena, materials and their properties, describing DC and AC circuits, describing the phenomenon of electromagnetic induction and describing the effect of magnetic field on conductors with electric current,
Code:	1150-00000-ISA-0116_W1
Verification:	Exam, test before admission to perform laboratory exercises
Connected field of study outcomes:	K_W01, K_W02, K_W17, K_W20.
Outcome:	Having the knowledge: of the influence of RLC circuit parameters on sinusoidal current and voltage waveforms, of the definition and the role of basic electrical components in electrical circuits, about basic issues describing transient states in RL and RC circuits.
Code:	1150-00000-ISA-0116_W2
Verification:	Exam, test before admission to perform laboratory exercises
Connected field of study outcomes:	K_W18, K_W19
Outcome:	Knowing the rules for defining and determining the power and energy in DC, single-phase AC and three-phase AC circuits.
Code:	1150-00000-ISA-0116_W3
Verification:	Exam, test before admission to perform laboratory exercises
Connected field of study outcomes:	K_W18, K_W19

Outcome:	Has knowledge about devices protecting the operation of electrical machines
Code:	1150-00000-ISA-0116_W4
Verification:	Exam, test before admission to perform laboratory exercises
Connected field of study outcomes:	K_W21.
Skills	
Outcome:	Knowing and being able to: build a measuring system, apply the rules for the proper connection of meters to measure selected electrical quantities,
Code:	1150-00000-ISA-0116_U1
Verification:	Exam, evaluation of tasks performed during the implementation of laboratory exercises, test before admission to exercise, evaluation of reports
Connected field of study outcome:	K_U11, K_U15; K_U16; K_U17; K_U18, K_U14, K_U09.
Outcome:	Knowing and being able to: calculate the corresponding multiplicity on the basis plot of the characteristic, eg. voltage from current, Knowing and being able to apply the rules of building Vector charts for various RLC connection configurations in AC circuits.
Code:	1150-00000-ISA-0116_U2
Verification:	Exam, evaluation of tasks performed during the implementation of laboratory exercises, test before admission to exercise, evaluation of reports
Connected field of study outcome:	K_U02, K_U03, K_U04, K_U11
Social competences	
Outcome:	Being able to work and collaborate in a group while performing laboratory exercises and developing reports with taking on various roles.
Code:	1150-00000-ISA-0116_K1
Verification:	Evaluation of the manner of performing tasks during the implementation of the exercises and evaluation of the report.
Connected field of study outcome:	K_K03, K_K04

Description of a Subject

SUBJECT: BASICS OF ENGINEERING DRAWING WITH ELEMENTS OF DESCRIPTIVE GEOMETRY II

Subject code	1150-MT000-ISP-0117
Subject version	Version I
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery
Profile of study	General academic
Degree program	Mechatronics
Supervising unit	Faculty of Automotive and Construction Machinery Engineering
Performing unit	Faculty of Automotive and Construction Machinery Engineering
B. General characteristics of the subject	
Subject kind	Connected with the field of study
Subject group	Basics of engineering drawing
Subject level	Basic
Subject status	Compulsory

Language of classes	English	
Nominal semester	II	
Pre-requisites	The subject requires knowledge gained during the class BASICS OF ENGINEERING DRAWING WITH ELEMENTS OF DESCRIPTIVE GEOMETRY in the 1st semester.	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	The aim of the subject is gaining practical knowledge of mapping spatial elements into a drawing sheet and creating technical documentation of machine elements popular in CAD systems.	
Learning outcomes	See **TABLE No 14**	
Form of classes and their duration	Lecture	
	Practicals	
	Laboratory	
	Project	45
Learning content	1. Elements of Engineering Drawing. 2. Rules for creating basic drawings and geometric construction elements. 3. Methods of mapping objects (shafts, sleeves, frames) 4. Views and sections in orthographic projections. 5. Dimensioning of machine element drawings. 6. Drawing of elements and machine element links. 7. Basic rules for making product layout drawings, system and subassembly drawings, and executive drawings of elements. 8. Using computer techniques in drawing making, recording and archiving.	
Evaluation methods	Credit for project practicals is granted based on individual grades from assignments performed by a student during classes.	
Ways of verifying learning outcomes	See **TABLE No 14**	
Exam	No	
D. Student's contribution		
Number of ECTS points	3	
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours- 47, including: a) project - 45 h.; b) consultations - 2 h. 2) Student's individual work 30 hours, including: a)10 h – student's current preparation for practicals, literature study, b) 20 h – doing individual projects, 3) TOTAL – sum of individual work and contact hours- 77.	
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,88 ECTS points – number of contact hours - 47, including: a) project - 45 h; b) consultations - 2 h.	
Number of ECTS points obtained by a student within practical classes:	3 ECTSpoints 1) participation in project classes - 45 h. 2) 30 hours of individual work on preparing for project classes and doing individual tasks.	
E. Additional information		
Comments		

TABLE No 14. SUBJECT OUTCOMES	
Knowledge	
Outcome:	A student knows and applies methods of object mapping, axonometric projecting and

	European projecting system.
Code:	1150-MT000-ISP-0117_W1
Verification:	Evaluation of an individual project.
Connected field of study outcomes:	K_W06, K_W01
Outcome:	A student has knowledge and skills in terms of presenting dimensioning of connectors and temporary fastenings.
Code:	1150-MT000-ISP-0117_W2
Verification:	Evaluation of an individual project realization.
Connected field of study outcome:	K_W06, K_W01
Outcome:	A student knows the stages of making a complex technical documentation of elements, subassemblies, systems, and ready products.
Code:	1150-MT000-ISP-0117_W3
Verification:	Evaluation of an individual project realization.
Connected field of study outcome:	K_W06, K_W01
Skills	
Outcome:	A student uses specialized literature well and knows CAD systems making engineering work easier, as well as can map elements of machines in the form of views and partial views, sections and partial sections, quad views and local quads and elevated sections, knows normalized rules for section hatching.
Code:	1150-MT000-ISP-0117_U1
Verification:	Evaluation of a student's individual project realization and preparing electronic documentation in CAD system.
Connected field of study outcome:	K_U03, K_U02, K_U06, K_U05,
Outcome:	A student knows how to draw typical temporary fastenings i.e. threaded, studs, keyway, as well as permanent fastenings: welded, riveted, soldered, glued, and stitched.
Code:	1150-MT000-ISP-0117_U2
Verification:	Evaluation of a student's individual project realization and preparing electronic documentation in CAD system.
Connected field of study outcome:	K_U03, K_U02, K_U06, K_U05,
Outcome:	A student knows how to apply rules for layout drawings, indicating parts in the drawings, rules for creating specifications of elements and for archiving and managing technical documentation.
Code:	1150-MT000-ISP-0117_U3
Verification:	Evaluation of a student's individual project realization and preparing electronic documentation in CAD system.
Connected field of study outcome:	K_U03, K_U02, K_U06, K_U05,
Social competences	
Outcome:	A student knows how to apply subject norms, properly interprets its guidelines, knows how to interpret technical norms also in a foreign language considered as a means of international communication within the chosen field of study. A student can work individually and as a member of a group.

Code:	1150-MT000-ISP-0117_K1
Verification:	Evaluation of a student's individual project realization and group discussion.
Connected field of study outcome:	K_K05, K_K01, K_K04.

Description of a Subject

SUBJECT: THEORETICAL MECHANICS I

Subject code	1150-00000-ISA-0118	
Subject version	Version I	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Compulsory	
Subject level	Basic	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	2	
Pre-requisites	Recommended formal attestation of the course of Mathematics prior to Theoretical Mechanics I. Knowledge in linear algebra and differential calculus.	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Understanding Mechanics as a knowledge on motion of particles, bodies, mechanisms, machines and vehicles. Formulation of basic laws of motion and state of rest of bodies and multibody systems. Understanding the nature and types of mechanical actions - forces and moments. Modeling of mechanical systems for the technical purposes. Geometrical conditions of equilibrium of a body and mechanical system. Important phenomena in mechanics related to dry friction. Understanding velocity and acceleration as vector functions of time. Ability to analyze motion of a particle under forces dependent on position, velocity and time. The role of internal forces in multi-body systems. Kinetic energy of a particle and multi-particle systems and its variations during motion.	
Learning outcomes	See **TABLE No 15**	
Form of classes and their duration	Lecture	30
	Practicals	30
	Laboratory	
	Project	
Learning content	Lecture: 1. Introduction Subject of Mechanics. Internal classification of Mechanics. Historical outline. Mechanics as a theory. Basic notions, Newton's laws. Parts of Theoretical Mechanics. SI units in Mechanics. 2. Vectors and vector calculus Scalars and vectors in Mechanics. Geometric and analytic description of vectors. Vector calculus. Vector functions of time. 3. Geometry of mass First moments of particles and bodies. Mass centers and centroids of bodies and figures. Pappus-Guldinus rules. Second moments of particles and	

	bodies - moments of inertia and product moments. Inertia matrix of a body. Transformation rules. Principal axes and principal moments of inertia of a body. Ellipsoid of inertia of a body. 4. Statics of particles, bodies and multibody systems Models of rigid bodies. Classification of forces. Types of supports. Problems and methods in Statics. Resultant of mechanical actions on a body. Wrench and resultant force. Geometric and analytical conditions of equilibrium. Dry friction and its effects in Statics. Plane trusses. 5. Kinematics of a particle Geometric and analytical description of motion of a particle. Trajectory of motion. Velocity and acceleration of a particle in Cartesian and cylindrical/polar coordinate systems. Natural directions of motion. Moving trihedral. Tangent and normal accelerations. Special cases: uniformly variable motion, harmonic motion, motion in a central field of acceleration. 6. Dynamics of a particle Equations of motion of a free and constrained particle. Motion of a particle under force dependent on time, position and velocity. Resistance of dry friction. Resistance dependent on velocity of motion. Momentum law. Angular momentum law. Work and power of a force. Kinetic energy law. Dynamics of a particle under potential force. Potential energy. Principle of mechanical energy conservation. Newton's law of gravitation. Escape velocity. 7. Dynamics of multi-particle systems Equations of motion. Constraints and their reactions. Momentum law. Angular momentum law. Kinetic energy law. Principle of mechanical energy conservation. Class exercises: 1. Calculations of mass center positions and moments of inertia of bodies. 2. Solving problems of statics without friction – positions of equilibrium and reactions of supports of bodies and mechanisms. 3. Solving problems of statics with dry friction – phenomena of self-locking and jamming, duality of loss of equilibrium, belt friction, resistance to rolling. 4. Calculations of velocities and accelerations in various reference systems. 5. Analysis of motion of a free particle under force dependent on position, velocity and time. Application of linear momentum law and angular momentum law for a particle. Making use of kinetic energy law and principle of conservation of energy in the case of a particle. 6. Application of linear momentum law in case of a multi-particle system. Law of motion of mass center. The role of internal forces in changes of the linear momentum and energy.
Evaluation methods	Lecture: written examination on skills and knowledge concerning the scope of the course. Class exercises: written tests on practical ability to solve simple problems as examples of theory presented within the lecture. Attestation of class exercises.
Ways of verifying learning outcomes	See **TABLE No 15**
Exam	Yes
D. Student's contribution	
Number of ECTS points	5
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours - 64, including; a) lecture - 30 h; b) practical – 30 h; c) consultations – 4 h. 2) Student's individual work - 61 h, including: a) ongoing preparation for exercises - 30 h; b) literature studies and current preparation for tests - 15 h;- c) preparation for the exam: 16 h. 3) TOTAL – 125.
Number of ECTS points for classes requiring direct participation of members of academic staff:	2,56 ECTS points – number of contact hours -64, including: a) lecture - 30 h; b) practical – 30 h; c) consultations – 4 h.

Number of ECTS points obtained by a student within practical classes:	2,4 ECTS points – number of contact hours -60, including: a) practical – 30 h; b) ongoing preparation for exercises - 30 h;
E. Additional information	
Comments	

TABLE No 15. SUBJECT OUTCOMES	
Knowledge	
Outcome:	The student knows fundamental quantities observed in mechanics such as force, mass, torque relative to a point, velocity, acceleration, angular velocity and acceleration, momentum, angular momentum, kinetic and potential Energy; knows their physical units and significance.
Code:	1150-00000-ISA-0118_W1
Verification:	Exam, written tests, evaluation of homework
Connected field of study outcomes:	K_W01, K_W03
Outcome:	Knows fundamental methods applied in general mechanics and knows which method should be selected to a given problem.
Code:	1150-00000-ISA-0118_W2
Verification:	Exam, written tests, evaluation of homework
Connected field of study outcomes:	K_W01, K_W03
Outcome:	Is able to explain phenomena of practical significance in mechanics and mechanisms related to motion of mechanical systems including self-locking, seizure, duality in the loss of an equilibrium state, statical indeterminacy, motion resistance, conservation of motion of centroids, free falling in the gravity field, energy conservation law.
Code:	1150-00000-ISA-0118_W3
Verification:	Exam, written tests, evaluation of homework
Connected field of study outcomes:	K_W01, K_W03
Outcome:	Understands cause-effect relationships in mechanics expressed in terms of laws of mechanics (equilibrium conditions, conservation laws) and possesses basic knowledge enabling making use of these laws in practical problems. Knows how to build a physical model of a real mechanical system.
Code:	1150-00000-ISA-0118_W4
Verification:	Exam, written tests, evaluation of homework
Connected field of study outcomes:	K_W01, K_W03
Skills	
Outcome:	The student can choose and apply and appropriate mechanical principle to solve the given problem. Can evaluate correctness of the obtained results qualitatively and quantitatively.
Code:	1150-00000-ISA-0118_U1
Verification:	Exam, written tests, evaluation of homework
Connected field of study outcome:	K_U01, K_U03
Outcome:	Can determine position of the center of gravity in a system of particles and rigid bodies and can calculate moments of inertia through the parallel axes theorem.
Code:	1150-00000-ISA-0118_U2
Verification:	Exam, written tests, evaluation of homework
Connected field of study	K_U01, K_U03

outcome:	
Outcome:	Can reduce an arbitrary spatial system of forces to a wrench. Can apply energy conservation law to a particle and a system of particles.
Code:	1150-00000-ISA-0118_U3
Verification:	Exam, written tests, evaluation of homework
Connected field of study outcome:	K_U01, K_U03
Outcome:	Can calculate reactions in supports of statically determinable two- and three-dimensional systems. Can solve problems in statics of systems with friction.
Code:	1150-00000-ISA-0118_U4
Verification:	Exam, written tests, evaluation of homework
Connected field of study outcome:	K_U01, K_U03
Outcome:	Can find velocity and acceleration of a particle in rectangular, polar and natural coordinate systems. Can solve problems of projectiles moving in a uniform gravity field with resistant forces taken into account as well as particles moving vertically in a non-uniform field.
Code:	1150-00000-ISA-0118_U5
Verification:	Exam, written tests, evaluation of homework
Connected field of study outcome:	K_U01, K_U03
Outcome:	The student can acquire information about the content of the subject from literature and online databases
Code:	1150-00000-ISA-0118_U6
Verification:	Exam, written tests, evaluation of homework
Connected field of study outcome:	K_U19

Description of a Subject	
SUBJECT: MANUFACTURING TECHNOLOGY	
Subject code	1150-00000-ISA-0119
Subject version	Version I
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery
Profile of study	General academic
Degree program	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering
Performing unit	Faculty of Automotive and Construction Machinery Engineering
B. General characteristics of the subject	
Subject kind	Connected with the field of study
Subject group	Compulsory
Subject level	Basic
Subject status	Compulsory
Language of instruction	English
Nominal semester	2

Pre-requisites	None	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Acquiring knowledge about cutting tools, basic machining process, cutting economics, classification of machining processes and advanced machining techniques. Gaining skills about setting or calculating cutting data. Acquiring knowledge about casting materials and classifical of casting process. Gaining experience in casting design and selection of appropriate casting method. Acquiring knowledge about welding, soldering and brazing. Gaining knowledge about theory of plasticity, metal forming, forming methods and forming machines. Acquiring competences about ability to individual work and work in a team.	
Learning outcomes	See **TABLE No 16**	
Form of classes and their duration	Lecture	45
	Practicals	
	Laboratory	
	Project	
Learning content	1. Definition of machining. Chipless forming as alternative of machining. Short history of manufacturing technology. Typical workpiece materials. 2. Cutting tools. Types and characteristics. Tool materials. Coatings. 3. Basic machining process. Cutting conditions: cutting speed, feed rate and the depth of cut. Chip formation and chip classification. Cutting forces and power. Heat in cutting. Cutting fluids: functions, types, safety concerns and degradation. Tool wear . Tool life curve. 4. Cutting economics. Economic tool-life and tool-life at maximum production rate. Production rate vs cutting speed curve and machining cost vs cutting speed curve. Machining cost vs tolerance curve. Selection of cutting speed, feed rate and the depth of cut dependent on production rate, cost, tolerance and stage (roughing or finishing) in cutting. 5. Classification of machining processes (turning, drilling, milling, sawing, broaching) and machining tools. Finish machining: grinding, honing, lapping, polishing. Advanced machining techniques: electric discharge machining (EDM), electrochemical erosion, laser cutting, water jet cutting. CNC machining. Trends in cutting practice. 6. Basic process. Casting materials. Design requirements of casting (draft, the gating system, parting surface, shrinkage). Pattern, moulding box, moulding materials, flask, core and core box. Moulding machines. 7. Classification of casting process: sand casting, permanent mould casting, investment casting (lost-wax casting), lost-foam casting, die casting (hot-chamber machines and cold-chamber machines), centrifugal casting (rotocasting) and shell-mould casting. 8. Casting defects and remedies. 9. Gas welding. Oxyacetylene blowpipe. 10. Electric arc. Arc welding: manual metal arc welding (MMA), metal inert gas welding (MIG), tungsten inert gas welding (TIG), flux-cored arc welding (FCA). And submerged arc welding (SAW). Welding joint types. Plate edge preparation. 11. Industrial application of welding. Advantages and disadvantages of welding. Classification of welding machines. 12. Laser beam welding. Plasma arc welding (PAW). Electron beam welding. 13. Electric resistance welding. Friction stir welding. Ultrasonic welding. Explosion welding. 14. Soldering and brazing. 15. Hardfacing and thermal spraying. 16. Different materials weldability depending on type of welding process. Welding defect: mayor causes, type of cracks, distortion. Welding joints quality control systems. 17. Short theory of plasticity and metal forming. Typical stress vs. strain diagram with the various stages of deformation. Flow curve. Definition of: dislocation slip, twinning deformation, work hardening, recrystallization temperature and recovery. 18. Material behaviour in metal forming. Temperature in metal forming: cold, worm and hot working. Friction and lubrication in metal forming. 19. Forging, rolling, extrusion, sheet metalworking: bending, deep drawing and shearing (die cutting), press	

	forming. 20. Forming machines (rolling mill, forging machine, press, drawing machine, swaging machine) and tools. 21. Design of forming manufacturing system (groups of machines or production line).
Evaluation methods	3 tests (Machining, welding and casting, plastic forming)
Ways of verifying learning outcomes	See **TABLE No 16**
Exam	No
D. Student's contribution	
Number of ECTS points	3
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours - 48, including; a) laboratory- 45 h; b) consultations – 3 h. 2) Student's individual work - 27 h, including: a) 27 h – literature studies and preparation for classes; 3) TOTAL – 75.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,92 ECTS points – number of contact hours - 48, including: a) lecture- 45 h; b) consultations – 3 h.
Number of ECTS points obtained by a student within practical classes:	
E. Additional information	
Comments	

TABLE No 16. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Has knowledge of the basics of mechanical engineering; 1) machining operations, cutting parameters, cutting tools, blade usage, machine tools for metals, 2) foundry materials, casting processes, foundry defects, 3) welding: gas welding, electric arc welding, welding advantages and disadvantages, laser welding, 4) processing plastic: has a basic knowledge of the theory of plasticity and plastic forming of metals, material behavior during forming forging, rolling, extrusion, drawing, bending, punching and plastic forming machines. Has elementary knowledge of organizing and conducting engineering design processes.
Code:	1150-00000-ISA-0119_W1
Verification:	Tests
Connected field of study outcomes:	K_W04, K_W06, K_W10, K_W16, K_W17, K_W20.
Skills	
Outcome:	The student is able to choose and determine the cutting parameters, primarily for turning and milling. He can select machine tools, casting methods, plastic forming methods and joining methods depending on the type of material, accuracy requirements and production volume.
Code:	1150-00000-ISA-0119_U1
Verification:	Tests
Connected field of study outcome:	K_U24,
Outcome:	The student can: in a very simplified way, design a pig iron; he can indicate the causes of weld joint damage and indicate methods for preventing their formation; he can indicate the causes of damage to components produced by plastic forming technologies and provide methods to prevent their formation

Code:	1150-00000-ISA-0119_U2
Verification:	Tests
Connected field of study outcome:	K_U15,
Social competences	
Outcome:	The student can be, as a future engineer, responsible for reliable knowledge acquisition.
Code:	1150-00000-ISA-0119_K1
Verification:	Assessment of activity and involvement in lectures and consultations as well as strict elimination of collections
Connected field of study outcome:	K_K03

Description of a Subject	
SUBJECT: STRUCTURAL MATERIALS LABORATORY	
Subject code	1150-00000-ISA-0120
Subject version	Version I
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery
Profile of study	General academic
Degree program	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering
Performing unit	Faculty of Automotive and Construction Machinery Engineering
B. General characteristics of the subject	
Subject kind	Connected with the field of study
Subject group	Compulsory
Subject level	Basic
Subject status	Compulsory
Language of instruction	English
Nominal semester	2
Pre-requisites	Completed lecture Structural Materials, knowledge of basic groups of materials, methods of their formation, structure and properties. Basic knowledge of subjects Mathematics, Chemistry, Physics (including units, symbolism, simple calculations, optics).
Limit of number of students	
C. Learning outcomes and the manner of conducting classes	
Aim of the subject	Transmission of knowledge about the microstructure of metallic materials, methods for disclosure, and the shaping influence of microstructure on the properties of materials. Introduction to basic heat treatment of materials (such as steel alloys and non-ferrous materials). Demonstration of relationship between the treating material, the resultant structure and performance. Presentation of the basic groups of metallic materials - iron base alloys, copper and aluminum alloys. Demonstration of the phenomena occurring during recrystallization of the material (for example

	brass) . Preliminary preparation to apply for the destruction of the basic mechanisms of metallic product.	
Learning outcomes	See **TABLE No 17**	
Form of classes and their duration	Lecture	
	Practicals	
	Laboratory	15
	Project	
Learning content	Preliminary exercise. Principles of metallographic, typical metallographic structure. Study of the effect of carbon on the microstructure and hardness of the alloys from Fe-Fe3C phase diagram. Plastic deformation and recrystallization. Heat treatment of structural steel (quenching and tempering). Microscopic examination of white, gray and ductile cast iron. Macroscopic studies. Major copper and aluminum alloys and ways of strengthening them (examples). Summary exercise.	
Evaluation methods	7 passing laboratory. The rating for the exercise is the result of the assessment of the preparation for the exercise and the evaluation report on the implementation of practical exercises. Include the evaluation of all positive with 7 laboratory exercises. The final grade is the result of partial marks. At the last class provided a summary of the exercises and discussion on the achievements of individual students.	
Ways of verifying learning outcomes	See **TABLE No 17**	
Exam	No	
D. Student's contribution		
Number of ECTS points	1	
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours- 16, including: a) laboratory - 15 h.; b) consultations – 1h; 2) Student's individual work 9 hours, including: a) ongoing preparation of the student for laboratory exercises, literature studies – 3 h; b) preparation of reports on completed laboratory exercises – 6 h; 3) TOTAL – sum of individual work and contact hours- 25 h.	
Number of ECTS points for classes requiring direct participation of members of academic staff:	0,64 ECTS points – number of contact hours - 16, including: a) laboratory - 15 h.; b) consultations – 1h;	
Number of ECTS points obtained by a student within practical classes:	0,96 ECTS points – number of contact hours - 24, including: a) laboratory - 15 h.; b) ongoing preparation of the student for laboratory exercises, literature studies – 3 h; c) preparation of reports on completed laboratory exercises – 6 h;	
E. Additional information		
Comments		

TABLE No 17. SUBJECT OUTCOMES	
Knowledge	
Outcome:	The student understands the principle of the formation of the image of the structure, knows the principle of revealing the structure in metal alloys, understands the concept of microstructure and its relationship with the production technique and basic functional features, can distinguish between single-phase and multi-phase structure.
Code:	1150-00000-ISA-0120_W1

Verification:	Passing positive tests from 6 laboratory exercises (exercises 2-7), passing positive reports prepared after each exercise (exercises 1-7).
Connected field of study outcomes:	K_W05, K_W15, K_W20
Outcome:	The student is able to recognize different types of steel due to the variable carbon content, indicate those that are characterized by higher hardness, justify the variability of hardness as a function of the carbon content. The student is able to recognize and name qualitatively different cast iron structures.
Code:	1150-00000-ISA-0120_W2
Verification:	Passing positive tests from 6 laboratory exercises (exercises 2-7), passing positive reports prepared after each exercise (exercises 1-7).
Connected field of study outcomes:	K_W05, K_W15, K_W20
Outcome:	TThe student can explain the changes taking place in the structure and properties of metallic materials subjected to plastic deformation and recrystallizing annealing. Is able to propose and make a simple experiment allowing to determine the recrystallization temperature of single-phase brass after a given crumple.
Code:	1150-00000-ISA-0120_W3
Verification:	Passing positive tests from 6 laboratory exercises (exercises 2-7), passing positive reports prepared after each exercise (exercises 1-7).
Connected field of study outcomes:	K_W05, K_W15, K_W20
Outcome:	. The student can explain the changes occurring in the steel subjected to the process of hardening and tempering. He can name the structures created during this process. Can justify the chemical composition of steels used for this strengthening process
Code:	1150-00000-ISA-0120_W4
Verification:	Passing positive tests from 6 laboratory exercises (exercises 2-7), passing positive reports prepared after each exercise (exercises 1-7).
Connected field of study outcomes:	K_W05, K_W15, K_W20
Outcome:	Student is able to list and indicate the way of splitting such light alloys as alloys on the basis of copper and alloys on the aluminum matrix. He can recognize the characteristic structures of these materials and draw conclusions about the way they are shaped. He can indicate which of them are suitable for casting, which are typical alloys for plastic processing and which ones can be strengthened by the mechanism of isolation.
Code:	1150-00000-ISA-0120_W5
Verification:	Passing positive tests from 6 laboratory exercises (exercises 2-7), passing positive reports prepared after each exercise (exercises 1-7).
Connected field of study outcomes:	K_W05, K_W15, K_W20
Outcome:	The student is able to perform and explain a simple experiment of strengthening dural by means of supersaturation and aging. Student is able to carry out simple observations of construction materials in the macro scale - perform the process of deep pickling of welds, reveal the decomposition of sulphides in steel, the Bauman method. He is able to identify and name characteristic forms of breakthroughs (fatigue, short-term, fragile, plastic) and explain how they form
Code:	1150-00000-ISA-0120_W6
Verification:	Passing positive tests from 6 laboratory exercises (exercises 2-7), passing positive reports prepared after each exercise (exercises 1-7).
Connected field of study outcomes:	K_W05, K_W15, K_W20

Skills	
Outcome:	Student is able to use devices such as metallographic microscope, Rockwell hardness tester, laboratory furnace, reagents for etching metal alloys.
Code:	1150-00000-ISA-0120_U1
Verification:	Passing positive reports prepared after each exercise (exercises 1-7).
Connected field of study outcome:	K_U12,K_U04, K_U03
Social competences	
Outcome:	The student is able to work in a group, to share responsibilities between partners in the experiment, to exchange results carried out as part of one task using different devices.
Code:	1150-00000-ISA-0120_K1
Verification:	Passing positive reports prepared after each exercise (exercises 1-7).
Connected field of study outcome:	K_K04

Description of a Subject		
SUBJECT: GEOMETRY MODELLING		
Subject code	1150-00000-ISA-0121	
Subject version	Version I	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Informatics	
Subject level	Basic	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	2	
Pre-requisites	None	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Presentation of basic techniques of geometric modelling.	
Learning outcomes	See **TABLE No 18**	
Form of classes and their duration	Lecture	
	Practicals	
	Laboratory	30
	Project	
Learning content	Laboratory: • Profile 2D creation. Constraints modeling in profile. Dimension constraints of profile. Solid objects creation via extrusion (subtraction, addition). Creation of holes, filets and champfers. • Creation of objects via revolution. Creation of reference objects (plane, line, point). • Advanced tools for creating profiles. Creation of objects via sweeping. • Creation of	

	objects via multisection solids. Shell. • Methods of coping objects. Mirror, rectangular/polar array, user's array. • Creation of helix line, modeling of spring. Part parameterization. • Axial modeling (shaft). • Body modeling. • Pipe modeling. • Modeling of assemblies. Analysis of assemblies, collisions finding. • Creation and simulation of mechanisms. • Creation of 2D part documentation.
Evaluation methods	tests
Ways of verifying learning outcomes	See **TABLE No 18**
Exam	No
D. Student's contribution	
Number of ECTS points	2
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours - 32, including; a) laboratory- 30 h; b) consultations – 2 h. 2) Student's individual work - 18 h, including: a) 18 h – preparation for laboratories; 3) TOTAL – 50.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,28 ECTS points – number of contact hours - 32, including: a) laboratory- 30 h; b) consultations – 2 h.
Number of ECTS points obtained by a student within practical classes:	*2* ECTS points – number of contact hours - 50, including: a) laboratory- 30 h; b) consultations – 2 h. c) preparation for laboratories - 18 h;
E. Additional information	
Comments	

TABLE No 18. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Will be able to operate with 3D parametric geometry modelling system.)
Code:	1150-00000-ISA-0121_W1
Verification:	Test-exercise
Connected field of study outcomes:	K_W05, K_W07.
Outcome:	Will be able to operate with 3D parametric geometry modeling system.
Code:	1150-00000-ISA-0121_W2
Verification:	Test-exercise
Connected field of study outcomes:	K_W05, K_W07.
Skills	
Outcome:	Will have ability to create 2D profile and to model constraints
Code:	1150-00000-ISA-0121_U1
Verification:	Test-exercise
Connected field of study outcome:	K_U10,
Outcome:	Will have ability to create simple parametric part model .
Code:	1150-00000-ISA-0121_U2
Verification:	Test-exercise
Connected field of study	K_U10,

outcome:	
Outcome:	will be able to create 2D documentation of part.
Code:	1150-00000-ISA-0121_U3
Verification:	Test-exercise
Connected field of study outcome:	K_U10,
Outcome:	Will have ability to create part model via solid modeling.
Code:	1150-00000-ISA-0121_U4
Verification:	Test-exercise
Connected field of study outcome:	K_U10,
Social competences	
Outcome:	Will be able to work individually and in a team
Code:	1150-00000-ISA-0121_K1
Verification:	Test-exercise
Connected field of study outcome:	K_K04

Description of a Subject		
SUBJECT: PHYSICS II		
Subject code	1150-00000-ISA-0122	
Subject version	Version I	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Compulsory	
Subject level	Basic	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	2	
Pre-requisites	None	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Acquisition by students of ordered knowledge and skills in solving tasks in the field of electricity, magnetism, electromagnetic waves and relativistic mechanics.	
Learning outcomes	See **TABLE No 19**	
Form of classes and their duration	Lecture	30
	Practicals	
	Laboratory	
	Project	
Learning content	(1) Electric charge and electric field. Coulomb and Gauss's Law - calculation of electric fields. (2) Capacitance. Electric potential and electric potential energy.	

	Electric dipole. Dielectric polarization. Ferroelectric and piezoelectric materials. (3) Electric current and resistance. Ohm's law. Microscopic interpretation of resistance. Temperature dependence of resistance. Kirchhoff's rules . Energy and power in electric circuits. (4) Magnetic field. Motion of charged particle in a magnetic field – Lorentz force. Biot- Savart's and Ampere's law. (5) Magnetic materials: dia- , para- and ferromagnetic materials. Electric motor - principles of operation. (6) Electromagnetic induction; Faraday's and Lenz's law. Eddy currents. Inductance, self-inductance. Current generator and alternator. (7) Electromagentic waves, Maxwell's equations. (8) Relativity. Galileo and Lorentz transformation. The consequences of the Lorentz transformation. (9) Relativistic mass, energy and momentum. Energy and momentum of photon
Evaluation methods	Two tests; 50% points must be obtained to pass the course.
Ways of verifying learning outcomes	See **TABLE No 19**
Exam	No
D. Student's contribution	
Number of ECTS points	2
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours - 32, including; a) lecture - 30 h; c) consultations – 2 h. 2) Student's individual work - 25 h, including: a) 5 h – literature study; b) 20 h – preparation for classes and laboratories; 3) TOTAL – 57.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,28 ECTS points – number of contact hours -32, including: a) lecture - 30 h; b) consultations – 2 h.
Number of ECTS points obtained by a student within practical classes:	
E. Additional information	
Comments	

TABLE No 19. SUBJECT OUTCOMES	
Knowledge	
Outcome:	The student has ordered knowledge in the field of electricity, including the concept and properties of electric field and electric potential, electric capacity, electric field energy, Coulomb and Gauss law, electric properties of matter, polarization of dielectrics, Clausius-Mosotti formula .; in the field of electricity, including the flow of charge, the concept of conductivity and electrical resistance and its temperature dependence, Ohm's and Kirchhoff's law, power and energy of electric current of time,
Code:	1150-00000-ISA-0122_W1
Verification:	written tests
Connected field of study outcomes:	K_W02, K_W03
Outcome:	The student has ordered knowledge in the field of magnetism, including the notion and properties of the magnetic field, Lorentz's force, Biotope's law Savarta, Ampere's law, Faraday's law of induction, the concept of inductance, magnetic field energy, magnetic properties of matter; has basic knowledge about electromagnetic waves including

	Maxwell equations in differential and integral form, electromagnetic spectrum; on the subject of relativistic mechanics, including the principle of relativity, Lorentz transformation, velocity transformations, shortening the length and elongation of time, elements of relativistic dynamics, the concept of space-time, interval.
Code:	1150-00000-ISA-0122_W2
Verification:	written tests
Connected field of study outcomes:	K_W02, K_W03
Skills	
Outcome:	The student can analyze issues in the field of electrostatics, currents, magnetism and electromagnetic waves.
Code:	1150-00000-ISA-0122_U1
Verification:	written tests
Connected field of study outcome:	K_U01

Description of a Subject		
SUBJECT: INTRODUCTION TO SOFTWARE ENGINEERING		
Subject code	1150-00000-ISA-0125	
Subject version	Version I	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Compulsory	
Subject level	Basic	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	2	
Pre-requisites	Basic knowledge of computer programming languages. Knowledge of the Windows environment and matrix account. Basic knowledge of computer programming languages.	
Limit of number of students	30 students per group	
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Obtaining basic knowledge of Matlab programming language in the task of signal analysis.	
Learning outcomes	See **TABLE No 20**	
Form of classes and their duration	Lecture	
	Practicals	
	Laboratory	15
	Project	
Learning content	Introduction to the Matlab environment in the task of signal analysis. The aim of the lecture is to familiarize students with the following topics Introduction to the Matlab environment, Algebra in Matlab, 2D & 3D graphics,	

	In/Out operations, Data flow control, Modular data programming.
Evaluation methods	Preparation test for laboratory classes (test at the beginning of classes). Evaluation of the quality of software written during classes. The point score is used: • test - 2 points, • exercise - 3 points To complete the exercise, you need 3 points. The final grade is the average of grades for all exercises (converted from point grades). All exercises are required.
Ways of verifying learning outcomes	See **TABLE No 20**
Exam	No
D. Student's contribution	
Number of ECTS points	1
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours - 16, including; a) laboratory - 15 h; c) consultations – 1 h. 2) Student's individual work - 9 h, including: a) ongoingpreparation for laboratory exercises -9 h; 3) TOTAL – 25.
Number of ECTS points for classes requiring direct participation of members of academic staff:	0,64 ECTS points – number of contact hours -16, including: a) laboratory - 15 h; b) consultations – 1 h.
Number of ECTS points obtained by a student within practical classes:	0,96 ECTS points – number of contact hours -24, including: a) laboratory – 15 h; b) ongoingpreparation for exercises -9 h;
E. Additional information	
Comments	

TABLE No 20. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Has basic knowledge about computer aidedengineering.
Code:	11500-00000-ISA-0125_W1
Verification:	Tests checking preparation for classes and the level of assimilation of previous exercises. Evaluation of the quality of the written software.
Connected field of study outcomes:	K_W01, K_W07, K_W08
Skills	
Outcome:	Can acquire information from literature, databases and sources, also in English; canintegrate the obtained information, make their interpretation and use in the construction of software.
Code:	1150-00000-ISA-0125_U1
Verification:	Tests checking the preparation for classes and the degree of acquiring knowledge from previous exercises. Evaluation of the quality of written software
Connected field of study outcome:	K_U06, K_U10
Social competences	
Outcome:	Has the ability to work individually.
Code:	1150-00000-ISA-0125_K1
Verification:	Evaluation of the task performed during the exercise.

Connected field of study outcome:	K_K04

Description of a Subject		
SUBJECT: THEORETICAL MECHANICS II		
Subject code	1150-00000-ISA-0201	
Subject version	Version I	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Compulsory	
Subject level	Basic	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	3	
Pre-requisites	Formal attestation of the course of Theoretical Mechanics I. Knowledge in linear algebra, differential calculus and fundamentals of functional analysis.	
Limit of number of students	According to the WUT Rector's ordinance	
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Understanding Mechanics as a knowledge on motion of particles, bodies, mechanisms, machines and vehicles. Formulation of basic laws of motion of bodies and multi-body systems. Description of position and motion of a body in 3D space. Laws of motion of a single body and a mechanism. Understanding phenomena occurring in rotating systems – dynamical reactions in bearings and gyroscopic effect. Understanding the effects of transportation in analysis of relative motion in a moving reference frame. Recognition of effective methods of analytical mechanics, including Lagrange equations. Understanding the phenomenon of impact in Mechanics with practical applications. Understanding the principles of motion of systems with variable mass with applications.	
Learning outcomes	See **TABLE No 21**	
Form of classes and their duration	Lecture	30
	Practicals	30
	Laboratory	
	Project	
Learning content	Lecture: 1. Kinematics of a rigid body: Description of position of a rigid body in space, Euler's angles. Classification of motions of a rigid body. Velocity and acceleration of points of a body in arbitrary motion, angular velocity and angular acceleration of a body. Particular motions of a body: translation, rotation about a fixed point, plane motion, screw motion. 2. Resultant motion of a particle: Description of motion of a particle in various reference frames. Transportation and relative motion. Kinematics of resultant motion. Transportation velocity and acceleration. Coriolis acceleration. Dynamics of relative motion of a particle. Relative equilibrium. 3. Dynamics of a rigid body: Kinetic energy of a body. König's theorem. Kinetic energy law. Principle of	

	conservation of mechanical energy in case of potential forces. Linear momentum of a body and linear momentum law. Angular momentum of a body and angular momentum law. Dyamics of a body in particular motions: translation, plane motion, precession, rotation about a fixed axis. Dynamic reactions in bearings of a rotor. Gyroscopic effect. Dynamics of a rolling wheel. Dynamics of vehicle traction. 4. Elements of analytical mechanics: Constraints and generalized coordinates of multiparticle systems. Concept of virtual displacements and virtual work. Principle of virtual work. D'Alembert's principle. Lagrange equations of motion. 5. Elementary collision theory: Impact forces. Dynamics of a particle under impact force. Collision of a particle with a massive body. Collision of two particles. Effect of an impact force on a body rotating about a fixed axis. Collision of two bodies in in-plane motions. 6. Dynamics of a particle with variable mass: Equation of motion. Particular cases of Mieszczerski's equation. Equation of motion of a rocket. Dynamics of a rocket with uniformly decreasing mass. Fuel consumption law of a rocket with constant acceleration. Class exercises: 1. Solving kinematic problems of bodies in particular motions – translatory motion, fixed point motion, plane motion, and rotation about fixed axis. Velocities and accelerations of points. Kinematics of a rolling wheel and a planetary gear. 2. Calculations of velocity and acceleration of a particle in a resultant motion. 3. Dynamics of a particle in relative motion analysed in a moving reference frame. 4. Calculations of the kinetic energy of bodies. Application of Koenig's formula. 5. Dynamics of rigid bodies in particular motions. Dynamics of a rolling wheel, and a vehicle. Dynamics of pure rotation of a body about a fixed axis. Calculations of dynamical reactions in bearings. 6. Analysis of dynamics of bodies in regular precession. Gyroscopic effect. 7. Exercises with Lagrange's equations of motion. 8. Calculations of impacts and collisions of particles and bodies. 9. Solving equations of motion of particles with variable mass. Motion of a rocket.
Evaluation methods	Class exercises: written tests on practical ability to solve simple problems as examples of theory presented within the lecture. Attestation of class exercises. Lecture: written examination on skills and knowledge concerning the scope of the course.
Ways of verifying learning outcomes	See **TABLE No 21**
Exam	Yes
D. Student's contribution	
Number of ECTS points	5
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours- 64, including: a) lecture - 30 h.; b) practicals – 30 h c) consultations - 4 h 2) Student's individual work 61 hours, including: a) 30 h – student's current preparation for practicals and lectures, literature study, b) 20 h – student's current preparation for tests, c) 11 h - student's current preparation for exam 3) TOTAL – sum of individual work and contact hours- 125 h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	2,56 ECTS points – number of contact hours - 64, including: a) lecture - 30 h.; b) practicals – 30 h c) consultations - 4 h
Number of ECTS points obtained by a student within practical classes:	
E. Additional information	

Comments	

TABLE No 21. SUBJECT OUTCOMES	
Knowledge	
Outcome:	The student knows the fundamental notions of classical mechanics such as force, mass, torque, linear and angular velocity and acceleration, momentum, angular momentum, kinetic and potential energy, knows their units, recognizes physical significance.
Code:	1150-00000-ISA-0201_W1
Verification:	Written and oral exam
Connected field of study outcomes:	KW_01, KW_03
Outcome:	The student knows basic methods used in mechanics and knows how to choose an appropriate method for a given task.
Code:	1150-00000-ISA-0201_W2
Verification:	Exam, written tests in-practical classes, evaluation of homework
Connected field of study outcomes:	KW_01, KW_03
Outcome:	Knows how to explain practical phenomena related to motion of mechanical systems and mechanisms such as gyroscopic effect, relative equilibrium, resistance to motion in a given medium, rolling resistance, slipping, traction of vehicles, collision of bodies, effect of variable mass on dynamics of a particle.
Code:	1150-00000-ISA-0201_W3
Verification:	Exam, written tests in-practical classes, evaluation of homework
Connected field of study outcomes:	KW_01, KW_03
Outcome:	Knows theoretical fundamentals enabling making use of methods of analytical mechanics to derive equations of balance and dynamics of mechanical systems (principle of virtual work, Lagrange's equations).
Code:	1150-00000-ISA-0201_W4
Verification:	Exam, written tests in-practical classes, evaluation of homework
Connected field of study outcomes:	KW_01, KW_03
Skills	
Outcome:	The student can select the proper law of mechanics and incorporate right method for solving the given problem. can calculate velocity and acceleration of a particle in the resultant motion (including Coriolis' acceleration).
Code:	1150-00000-ISA-0201_U1
Verification:	Exam, written tests in-practical classes, evaluation of homework
Connected field of study outcome:	K_U01, K_U03
Outcome:	The student can solve problems of relative dynamics of particles and can analyze relative equilibrium, can determine kinetic energy of a rigid body through Koenig's theorem. can find dynamical reactions in the supports of rotating shafts.
Code:	1150-00000-ISA-0201_U2
Verification:	Exam, written tests in-practical classes, evaluation of homework
Connected field of study outcome:	K_U01, K_U03
Outcome:	The student can derive equations of motion of mechanical systems be applying Lagrange's formalism of analytical mechanics. can solve model problems related to collisions between particles and rigid bodies.

	can solve dynamical problems of particles with mass varying in time.
Code:	1150-00000-ISA-0201_U3
Verification:	Exam, written tests in-practical classes, evaluation of homework
Connected field of study outcome:	K_U01, K_U03

Description of a Subject		
SUBJECT: STRENGTH OF MATERIALS I		
Subject code	1150-00000-ISA-0202	
Subject version	Version I	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Compulsory	
Subject level	Basic	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	3	
Pre-requisites	Basic knowledge in mathematics, construction materials and mechanics (listening to the lecture Mathematics, Materials, Mechanics I)	
Limit of number of students	According to the WUT Rector's ordinance	
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Understanding the fundamentals of material mechanics, including the state of stresses and deformations in mechanical construction elements, necessary for conducting strength analyzes of constructions.	
Learning outcomes	See **TABLE No 22**	
Form of classes and their duration	Lecture	30
	Practicals	30
	Laboratory	
	Project	
Learning content	Lecture. Preliminary information. / Basic assumptions. Internal forces in constructional systems - classification of simple strength problems. Basic concepts - stress, deformation, displacement. Basic relationships. Hooke's Law. Principle de Saint Venant. Mechanical properties of materials. Static tensile test. Tension/compression/ of axially loaded rods. Internal forces. Stress. Displacement. Statically indetermined axially loaded systems of rods. Thermal stress. Assembly stresses. / Moments of inertia. Steiner's Theorem. Mohr,s circle for moment of inertia. / Problem of twisting of circular cross section shafts. Internal forces. Stress state. Tangential stresses. Equilibrium equation. Displacement in twisted shafts. Shafts twisted statically and statically indetermined systems. Strength calculations of twisted shafts. Bending of beams / Internal forces in straight and curved beams. Equilibrium equations. Normal and tangential stresses. Shear stresses. Non parallel bending. Displacement in bending beams. Equation of bent axis. Boundary conditions. Clebsch's method.Superposition method. Statically indetermined bending	

	problems. Plane stress state and plane strain state. / Transformation of stress state components. Principle directions for plane state stress. Principal stresses. Mohr.s circle for stress state. Transformation of deformation state components. Principle directions forplane state of deformation. Principle strains. Mohr,s circle for deformation state. Generalized Hooke's Law / . Yield hypothesis. Equivalent stress. Galilean hypothesis. Mariott's hypothesis. Tresca Hypothesis. Beltrami's hypothesis. Huber'-Mises- Hencky hypothesis. Principles of strength calculations for constructional elements under compex loading. Exercises. Tension/compression/ One-dimensional problems of loaded rods - calculation of deformations and stresses in straight rods. Simple statically determined and indetermined systems. Thermal stress. Assembly stresses. Moments of inertia of cross-sections. One-dimensional problems of circular cross sectiobn bars: calculation of deformation and stresses in twisted shafts. Simple cases not statistically determined systems. Bending of beams. Calculation of internal forces in beam systems - straight and curved rods, Flat frames. Normal and shear stresses. Deflection line. Determination of displacements by the Clebsch method. Analysis of the stress state. Mohr's circele for plane stress /strain/ state. Yield hypothesis for plane Stress Condition. Examples of strength calculations for elements under complex loading.
Evaluation methods	Exercise: To complete /pass/ the exercises, you need to get a positive scores from all 4 colloquia. Passing the exercises is a prerequisite for taking the final exam. Lecture: The Strength of materials I course is summatised by a written exam. Exam consists of two parts (both sat at the same day –approximately 2,5 hours): Part A problem solving /1,5 h/ PART B. Theoretical /0,5 h/ Mark 4 or higher, grants automatical pass of PART A of the Exam – this students will write ONLY PART B. Final grade from the course is based on a positive assessment from the exercises and the exam.
Ways of verifying learning outcomes	See **TABLE No 22**
Exam	Yes
D. Student's contribution	
Number of ECTS points	5
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours- 64, including: a) lecture - 30 h.; b) practicals – 30 h; c) consultations - 4 h; 2) Student's individual work 61 hours, including: a) 30 h – student's current preparation for practicals and lectures, literature study, b) 20 h – student's current preparation for tests, c) 11 h - student's current preparation for exam 3) TOTAL – sum of individual work and contact hours- 125 h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	2,56 ECTS points – number of contact hours - 64, including: a) lecture - 30 h.; b) practicals – 30 h; c) consultations - 4 h;
Number of ECTS points obtained by a student within practical classes:	
E. Additional information	
Comments	

TABLE No 22. SUBJECT OUTCOMES

Knowledge	
Outcome:	He knows the basic concepts and relationships. / Stress, strain, Principe de Saint Venanta. Hooke's Law. Has knowledge of the mechanical properties of construction materials. Has knowledge about the determination during stretching (compression): internal forces, stresses, displacements in statically determinate and indeterminate systems. Has knowledge about stress accumulation, thermal stress and assembly stresses. Has knowledge of conducting tensile strength (compression) calculations.
Code:	1150-00000-ISA-0202_W1
Verification:	Exam. Written test during exercises.
Connected field of study outcomes:	K_W01, K_W03; K_W04; K_W05, K_W06
Outcome:	Has knowledge about the issue of twisting bars with circular cross-sections / internal forces, stresses, angular displacements / in statically determinate and indeterminate systems. He can determine geometrical characteristics of the cross-section. Has knowledge of strength and stiffness calculations of twisted rods with circular cross-sections.
Code:	1150-00000-ISA-0202_W2
Verification:	Exam. Written test during exercises.
Connected field of study outcomes:	K_W01; K_W04; K_W05; K_W06
Outcome:	He knows the rules for determining internal forces when bending straight and curved rods. Has knowledge about the determination of normal and tangential stresses in bending. He knows the issue of technical shearing. Has basic knowledge about calculations of glued, riveted, bolt connections. He knows the equation of the deflected axis. He knows the rules and methods for determining displacement in a bent rod. He knows the principles of strength and stiffness calculations for bending beams, flat frames - statorically determinate.
Code:	1150-00000-ISA-0202_W3
Verification:	Exam. Written test during exercises.
Connected field of study outcomes:	K_W01; K_W04; K_W05; K_W06
Outcome:	He knows the basics of stress state. / Stress state components at point, transformation of stress state components, main directions for stress state and main stresses, interpretation by Mohr circle /. He knows the relationship between the state of stress and strain.
Code:	1150-00000-ISA-0202_W4
Verification:	Exam. Written test during exercises.
Connected field of study outcomes:	K_W01; K_W04; K_W05; K_W06
Outcome:	He knows the basics of determining the reduced stress according to the given hypothesis / Tresca, Huber /. Has the knowledge of performing strength calculations for structural elements in conditions of a complex flat state of stress
Code:	1150-00000-ISA-0202_W5
Verification:	Exam. Written test during exercises.
Connected field of study outcomes:	K_W01; K_W04; K_W05; K_W06
Skills	
Outcome:	He can determine the internal forces. He can perform strength calculations for stretching (compression) in statically determinate and indeterminate systems. Umie analizować zagadnienie skręcania prętów o przekrojach kołowych. . Umie wykonać obliczenia wytrzymałościowe i sztywnościowe prętów skręcanych o

	przekrojach kołowych..
Code:	1150-00000-ISA-0202_U1
Verification:	Exam. Written test during exercises.
Connected field of study outcome:	K_U06, K_U07
Outcome:	He can determine internal forces, stresses in beams and flat frames - statically determinate. He can determine displacements in straight beams. He can perform strength and stiffness calculations on bending such structures.
Code:	1150-00000-ISA-0202_U2
Verification:	Exam. Written test during exercises.
Connected field of study outcome:	K_U06, K_U07
Outcome:	Is able to carry out an analysis of stress or strain / main directions for the stress state and main stress, give an interpretation of the stress state using the Mohr circle. Unie determine the stresses reduced according to the given hypothesis / Tresca, Huber /. Is able to carry out strength calculations for structural elements, in conditions of a complex flat state of stress ..
Code:	1150-00000-ISA-0202_U3
Verification:	Exam. Written test during exercises.
Connected field of study outcome:	K_U06, K_U07

Description of a Subject	
SUBJECT: ELECTRICAL AND ELECTRONICS ENGINEERING II	
Subject code	1150-PE000-ISA-0203
Subject version	Version I
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery
Profile of study	General academic
Degree program	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering
Performing unit	Faculty of Automotive and Construction Machinery Engineering
B. General characteristics of the subject	
Subject kind	Connected with the field of study
Subject group	Compulsory
Subject level	Basic
Subject status	Compulsory
Language of instruction	English
Nominal semester	3
Pre-requisites	
Limit of number of students	According to the WUT Rector's ordinance
C. Learning outcomes and the manner of conducting classes	
Aim of the subject	After completing the course the student should have a general theoretical knowledge on: - basic phenomena describing circuits electronic, - basic phenomena describing electric machines rotating and transformer (motor, generator, inverter) The student should be able to perform basic: - measurements of nonelectrical quantities.

Learning outcomes	See **TABLE No 23**	
Form of classes and their duration	Lecture	15
	Practicals	
	Laboratory	15
	Project	
Learning content	Lecture • Semiconductor diode, • Zener diode • The transistor: construction and operation, systems of work • Amplifier: construction and operation, systems of work • Inverter: construction and operation, systems of work, • Generator: construction and operation, systems of work • Transformer: construction and operation, systems of work • The generator DC: construction and operation, systems of work, • The generator AC: construction and operation, systems of work, • The motor DC: construction and operation, systems of work, • The motor AC: construction and operation, systems of work, Laboratory • Measurement of basic parameters of DC motor. • Measurement of basic parameters of DC generator. • Measurement of basic parameters of transformer. • Measurement of basic parameters of AC motor one phase. • Measurement of basic parameters of inverter • Measurement of basic parameters of Amplifier	
Evaluation methods	2 tests, written and oral exam	
Ways of verifying learning outcomes	See **TABLE No 23**	
Exam	Yes	
D. Student's contribution		
Number of ECTS points	2	
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours- 32, including: a) lecture – 15 h; b) laboratory - 15 h.; c) consultations – 2h; 2) Student's individual work 18 hours, including: a) preparation for classes (including literature studies) - 8 h; b) preparation for the tests and exam: 10 h. 3) TOTAL – sum of individual work and contact hours- 50 h.	
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,28 ECTS points – number of contact hours - 32, including: a) lecture – 15 h; b) laboratory - 15 h.; c) consultations – 2h;	
Number of ECTS points obtained by a student within practical classes:	1,2 ECTS points – number of contact hours - 30, including: a) laboratory - 15 h.; b) preparation of a laboratory report – 5 h; c) preparation of classes - 10 h.	
E. Additional information		
Comments		

TABLE No 23. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Having basic knowledge and being able to describe the structure, principle of operation and influence of the operating mode on the parameters of the transformer. Having basic knowledge about the principles of torque in electrical machines. Having basic knowledge and being able to describe the construction and explain the principle of operation of three-phase and singlephase asynchronous machines and synchronous machines.
Code:	1150-PE000-ISA-0203_W1

Verification:	Exam, test before admission to exercise
Connected field of study outcomes:	K_W02, K_W03, K_W12,
Outcome:	Being able to draw external characteristics for electric machines operating in generator mode and justify their shape and characteristic. Being able to draw mechanical characteristics for electric machines and justify their shape and curve.
Code:	1150-PE000-ISA-0203_W2
Verification:	Exam, test before admission to exercise
Connected field of study outcomes:	K_W02, K_W03, K_W12,
Outcome:	Having basic knowledge and being able to describe the methods of speed control of DC machines. Having basic knowledge and being able to explain the principle of operation of basic electronic circuits, eg. rectifier, amplifier and generator.
Code:	1150-PE000-ISA-0203_W3
Verification:	Exam, test before admission to exercise
Connected field of study outcomes:	K_W02, K_W03, K_W12,
Outcome:	Having basic knowledge of feedback circuits and their influence on the performance of amplifier.
Code:	1150-PE000-ISA-0203_W4
Verification:	Exam, test before admission to exercise
Connected field of study outcomes:	K_W02, K_W03, K_W12,
Skills	
Outcome:	Knowing and being able to build a measuring system.
Code:	1150-PE000-ISA-0203_U1
Verification:	Assessment of tasks performed during the implementation of laboratory exercises.
Connected field of study outcome:	K_U01, K_U02, K_U12
Outcome:	Knowing and being able to apply the rules for the proper connection of meters to measure selected electrical quantities. Being able to calculate the corresponding multiplicity and on this basis plot of the characteristic, eg. voltage from current, torque from rotational speed.
Code:	1150-PE000-ISA-0203_U2
Verification:	Assessment of the performance of tasks during the implementation of laboratory exercises, a test before admission to perform exercises, evaluation of reports.
Connected field of study outcome:	K_U01, K_U02, K_U12
Outcome:	Knowing and being able to apply rules for building vector diagram transformer parameters for various operation modes..
Code:	1150-PE000-ISA-0203_U3
Verification:	Exam, test before admission to exercise
Connected field of study	K_U01, K_U02, K_U12

outcome:	
Social competences	
Outcome:	Being able to work and collaborate in a group while performing laboratory exercises and developing reports with taking on various roles.
Code:	1150-PE000-ISA-0203_K1
Verification:	Evaluation of the manner of performing tasks during the implementation of the exercises and evaluation of the report.
Connected field of study outcome:	K_K04, K_K03

Description of a Subject		
SUBJECT: THEORY OF MACHINES AND AUTOMATIC CONTROL		
Subject code	1150-MT000-ISA-0204	
Subject version	Version I	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Compulsory	
Subject level	Basic	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	3	
Pre-requisites	Algebra - complex numbers, polynomials. Analysis - ordinary differential equations. Basics of trigonometry, geometry and vector calculus. Theoretical mechanics I - moments of inertia, kinematics of a particle.	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	After completion of the course student should have acquired: - basic knowledge of planar mechanisms, machine dynamics and control theory, - ability to describe kinematic and dynamic properties of planar mechanisms and simple machines, - ability to prepare time and frequency characteristics of simple elements and control systems, - ability to use stability criteria.	
Learning outcomes	See **TABLE No 24**	
Form of classes and their duration	Lecture	30
	Practicals	
	Laboratory	
	Project	15
Learning content	1. Classification of kinematic pairs. Structural formula. Overconstraints. Four-bar chain. Examples. 2. Planar mechanisms and their classification. Methods of determining velocities and accelerations in planar mechanisms. 3. Velocity and acceleration schemes in mechanisms, incl. Coriolis acceleration. Four-bar linkage. Grashof's conditions. 4. Analytical methods for determining velocities and	

	accelerations in plane mechanisms. 5. Cam mechanisms. Methods for determining velocities and accelerations. 6. Synthesis of cam mechanisms. Kinematics of Cardan mechanism. 7. Dynamics of plane mechanisms. Method of reduced mass. Inertia forces. 8. Analytic-graphical method for determining forces in plane mechanisms. 9. Machine dynamics. Reduction of masses and forces. Machine equation of motion. Non-uniformity of machine motion. Flywheel. 10. Basic notions of automatic control. Principles of operational calculus. 11. Types of system inputs. Input time- and frequency characteristics. 12. Characteristics of basic automatic control elements in the time- and frequency domains. Inertialess elements. Inertial elements of the 1-st and 2-nd order. Integral, derivative and time delay elements. 13. Block diagram algebra. 14. Types of controllers. Proportional-plus-itegral-plusdifferential controller. Stability of linear automatic control systems. 15. Hurwitz and Nyquist criteria of stability. Module and phase stocks. System correction. **Project class contents – overview** 1. Kinematic analysis of a given mechanism. 2. Dynamic analysis of a given machine – inertia end forces reduction, solution of a machine equation of motion and flywheel calculation. 3. Project of a control system for a simple mechanical system with stability analysis.
Evaluation methods	Exam: written examination on skills and knowledge after completing and successful attestation of project classes. During the course students perform three individual projects according to class schedule. To pass the class all projects must be accepted by teacher and total number of 13 points must be achieved.
Ways of verifying learning outcomes	See **TABLE No 24**
Exam	Yes
References	R. S. Khurmi, J. K. Gupta, Theory of Machines, chapters 5-10. Jacqueline Wilkie, Michael Johnson, Reza Katebi, Control engineering - An introductory course. Jan Willem Polderman, Jan C. Willems, Introduction to the Mathematical Theory of Systems and Control, chapters 7-8. T. Kołacin, Podstawy teorii maszyn i automatyki, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa, 2005.
Subject website	https://usosweb.usos.pw.edu.pl/kontroler.php?_act ion=katalog2/przedmioty/pokazPrzedmiot&prz_ko d=1150-MT000-ISA-0204
D. Student's contribution	
Number of ECTS points	4
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours- 48, including: A_ lecture – 30 h; b) project - 15 h.; c) consultation -3h; 2) Student's individual work 52 hours, including: a) preparation for lectures and project classes (including literature studies) - 10 h; b) preparation for test - 12 h. c) preparation for exam - 10 h. d) preparation of projects – 20 h. 3) TOTAL – sum of individual work and contact hours- 100 h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,92 ECTS points – number of contact hours - 48, including: a) lecture – 30 h; b) project - 15 h.; c) consultation -3h;
Number of ECTS points obtained by a student within practical classes:	1,8 ECTS points – number of contact hours - 45, including: a) project - 15 h.; b) preparation of project – 20 h; c) preparation for lectures and project classes (including literature studies) - 10 h.

E. Additional information	
Comments	

TABLE No 24. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Has the basic knowledge on application of laws and principles of Mechanics to describe motion of mechanisms and machines and analyze the dynamics of their elements and whole systems including stability in case of automatic control.
Code:	1150-MT000-ISA-0204_W1
Verification:	Individual projects and exam.
Connected field of study outcomes:	K_W01; K_W03
Skills	
Outcome:	Is skilled to apply analytical and graphical methods to determine kinematic and dynamic parameters of mechanisms and machines, incl. automatic control systems and their elements.
Code:	1150-MT000-ISA-0204_U1
Verification:	Individual projects and exam.
Connected field of study outcome:	K_U01

Description of a Subject	
SUBJECT: METROLOGY AND INTERCHANGEABILITY	
Subject code	1150-PE000-ISA-0205
Subject version	Version I
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery
Profile of study	General academic
Degree program	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering
Performing unit	Faculty of Automotive and Construction Machinery Engineering
B. General characteristics of the subject	
Subject kind	Connected with the field of study
Subject group	Compulsory
Subject level	Basic
Subject status	Compulsory
Language of instruction	English
Nominal semester	3
Pre-requisites	Students shall be able to calculate elementary derivatives and be familiar with fundamentals of the probability calculus. Ability to blue print reading and components technical sketching is compulsory.
Limit of number of students	150 for lecture; 30 per class practicals
C. Learning outcomes and the manner of conducting classes	
Aim of the subject	Student by credit the course shall get knowledge, skills and competences that are necessary to: • usage of the ISO code system for tolerances and fit for linear sizes ; • estimation of measurement uncertainties and application of hand measuring equipment for measurement of geometrical quantities ; • tolerance

	stack-up performance • specification and explanation of geometrical tolerances; • determine the need and concept of the use of the coordinate measuring systems	
Learning outcomes	See **TABLE No 25**	
Form of classes and their duration	Lecture	15
	Practicals	15
	Laboratory	
	Project	
Learning content	Lecture 1. Measurements and their uncertainty. Measurement and measurement principle. Quantity intended to be measured (measurand) in the measurement of length and angle. Direct and indirect measurement methods. Direct comparison, differential and deflection methods of measurement. The main causes of measurement errors: method, equipment and personnel. Measurement result as random variable. Systematic and random errors. Mistakes. Corrections. Assessment of the standard and expanded measurement uncertainty of the single and average measurement result. Type A and B evaluation of measurement uncertainty. Evaluation of measurement uncertainty by a statistical analysis of measured quantity values (type A evaluation) – big number of measurements in series (usage of Student's distribution) and small number of measurements in series (usage of Gaussian distribution). Combined uncertainty of indirect measurements. 2. Dimensional chains. Simple and 2D dimensional chains. Assembly and technological dimensional chains. Identification of the dependent dimension. The tolerance stuck up sketch. Equation of the nominal dimension, equations of upper and lower limit dimensions. Tolerance stuck up equation. Calculation of the limit dimensions – worst-case tolerance analysis and statistical tolerance analysis. Min-max method. Expansion of dimensional chain equation to Taylor series. Calculating of the selected dimension limits when all other dimensions are given. Calculating of the component dimensions limits when only dependent dimension limits are known. Rule of the shortest dimensional chain. Total and statistical interchangeability. Interchangeability due to fixing, additional cutting or selection. 3. Geometrical tolerancing according to ISO GPS system. Features of the workpiece – nominal, actual, extracted (integral and derived). Partition of the extracted profile. Tolerance indicator. Datum indicator. Tolerances and deviations of form – straightness, flatness, circularity & cylindricity. Datums, datum features, datum simulators. Single datums, common datums & datum systems. Datum targets. Tolerances and deviations of orientation – parallelism, perpendicularity or angularity of a feature to one or more datums. Tolerances and deviations of location – position, concentricity & symmetry. Tolerances and deviations of profile of a line/surface used to control form or combinations of size, form, orientation & location of a feature(s) relative to a true profile. Tolerances and deviations of circular runout tolerance and total run-out tolerance – radial and axial. Relations between selected geometrical tolerances. Fundamental ISO GPS system principles. Maximum material requirement for tolerance feature and datum feature. Envelope requirement. 4. Measurement equipment and auxiliary equipment. General concepts and requirements for GPS measuring equipment. GPS measuring equipment classification – material measures, transducers, indicating measuring instruments. Metrological characteristics and design characteristics (scale range, measuring range, scale interval maximum permissible error MPE, measuring force). Calibration. 5.Selected examples of measurement of the geometrical characteristics. Gauge blocks and their usage. Testing of sizes by callipers and micrometers. Differential measurements with dial gauges. Measurement of form deviations. Measuring microscopes. Coordinate measuring systems (CMM, ACCMM, 3D optical scanners, metrotomography). Cloud of points used for assessment of the conformity with specifications. Criteria for the selection of measuring equipment.	

	Classes 1. Tolerances and fits. ISO code system for tolerances on linear sizes. Basic terminology (feature of size, nominal size. limits of size, upper limit deviation, lower limit deviation, fundamental deviation). Tolerance interval – minmax interpretation and statistical interpretation). Tolerance class – combination of a fundamental deviation and a standard tolerance grade. Clearance fit. Interference fit. Transition fit. Holebasis fit system. Shaft-basis fit system. 2. Systematic errors and contributions to measurement uncertainty of linear dimensional measurements due to thermal influences. Calculations of the measurement uncertainty for direct and indirect measurement methods. Calculation of the standard and expanded measurement uncertainty of the single and average measurement result. 3. Dimensional chains. identification of the dependent dimension. The tolerance stuck up sketch. Calculations of the limit dimensions for 1D assembly and technological dimensional chains. Calculations of the component dimensions limits when only dependent dimension limits are known. Calculations of the limit dimensions for 1D dimensional chain due to fixing or additional cutting. 4. Practice in form, orientation, location, run out and MMR tolerance specification and interpretation for given workpieces.
Evaluation methods	The knowledge and skills of students are assessed regularly during classes and through tests. Each of the four test is assessed in scale from 0 to 5 points. The performance during classes e.i. solution of exercises, tasks and problems during classes at the blackboard in front of the group as well as individually under supervision and assistance of lecturer. For corect answer student can earn extra 0,5 point. The final assessment is established on the basis of the total number of points obtained in the semeste. To complete the course student shall collect more than 11 points (above 11. 0 to 12,5 final mark 3. 0; above 12. 5 to 14. 0 final mark 3,5; above 14. 0 to 16. 0 final mark 4. 0; above 16,0 to 18,0 final mark 4,5; above 18,0 final mark 5. 0.
Ways of verifying learning outcomes	See **TABLE No 25**
Exam	No
D. Student's contribution	
Number of ECTS points	2
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours- 32, including: a) lecture – 15 h; b) practicals - 15 h.; c) consutation – 2h; 2) Student's individual work 18 hours, including: a) preparation for classes (including literature studies) - 8 h; b) preparation for tests: 10 h. 3) TOTAL – sum of individual work and contact hours- 50 h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,28 ECTS points – number of contact hours - 32, including: a) lecture – 15 h; b) practicals - 15 h.; c) consutation – 2h;
Number of ECTS points obtained by a student within practical classes:	
E. Additional information	
Comments	

TABLE No 25. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Student understands that geometrical deviations and measurement uncertainties are inherently associated with all manufacturing and measurement processes. Real workpieces

	always have form, orientation, location and run-out deviations while the designer task is to apply tolerances that limit maximum permissible deviations within which the workpices fulfils requested functional requirements. Student can identify fit type and is able to select shafts/holes to obtained particular fit.
Code:	1150-PE000-ISA-0205_W1
Verification:	Test. Discussion, evaluation of exercise, task and problem solutions during classes in front of the group as well as individually performed under supervision and assistance of lecturer
Connected field of study outcomes:	K_W15
Outcome:	Student is familiar with stack-up methods that shall be applied during design of assemblies and devices with required interchangeability. Student understands the geometrical tolerancing symbols in engineering drawings and explain specified requirements.
Code:	1150-PE000-ISA-0205_W2
Verification:	Test. Discussion, evaluation of exercise, task and problem solutions during classes in front of the group as well as individually performed under supervision and assistance of lecturer
Connected field of study outcomes:	K_W15
Outcome:	Student knows measuring principles and methods, and criteria for selection of measuring equipment for dimensional and geometrical requirements. Student can present expanded uncertainty evaluation methods for direct and indirect measurements and demonstrate the criteria for conformity assessment with a specification.
Code:	1150-PE000-ISA-0205_W3
Verification:	Test. Discussion, evaluation of exercise, task and problem solutions during classes in front of the group as well as individually performed under supervision and assistance of lecturer
Connected field of study outcomes:	K_W15
Skills	
Outcome:	Student can design clearance/transition/interference fit, i.e. calculate the limit deviations for shaft/hole to assemble it with basic hole/shaft according to required fit type Student can estimate uncertainty of direct and indirect measurements and implement criteria for assessment of workpiece conformity to specification.
Code:	1150-PE000-ISA-0205_U1
Verification:	Verification of knowledge takes place in writing by answering the question posed. Verification of knowledge is also carried out in writing at the beginning of each laboratory exercise, where the student must solve the task assigned to him.
Connected field of study outcome:	K_U03, K_U09
Outcome:	Student can apply stack-up algorithms necessary to design assemblies and machines with required interchangeability. Student can assess the correctness of dimensional and geometrical tolerances given in a figure. Student can apply (specify) for a simple component tolerances of form, orientation, position, run-out and tolerances with maximum material requirement modifier.
Code:	1150-PE000-ISA-0205_U2
Verification:	Verification of knowledge takes place in writing by answering the question posed. Verification of knowledge is also carried out in writing at the beginning of each laboratory exercise, where the student must solve the task assigned to him.
Connected field of study outcome:	K_U03, K_U09
Outcome:	Student can select and suggest methods and measuring equipment that shall be used for

	verification of the elementary dimensional and geometrical requirements.
Code:	1150-PE000-ISA-0205_U3
Verification:	Test. Discussion, evaluation of exercise, task and problem solutions during classes in front of the group as well as individually performed under supervision and assistance of lecturer
Connected field of study outcome:	K_U03, K_U09
Social competences	
Outcome:	Student is aware that ISO GPS system is internationally recognized and accepted system of graphical symbols that facilitates communication and exchange of information between designers, production and quality control engineers that work together for automobile producers and their suppliers at various locations all over the world..
Code:	1150-PE000-ISA-0205_K1
Verification:	Students performance in social competence is verified during classes where ability to group cooperation and discussion is required.
Connected field of study outcome:	K_K04, K_K01

Description of a Subject		
SUBJECT: FLUID MECHANICS		
Subject code	1150-MT00-ISA-0206	
Subject version	Version I	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Full-time study	
Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Basic	
Subject group	Basic	
Subject level	Advanced	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	III	
Pre-requisites	Mathematics: vector analysis and field theory in three-dimensional space. Strength of materials: stress and strain states of material mediums.	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Learning physical values characterizing state of fluid and law defining phenomena in fluids, enabling establishing and analyzing hydrostatic strains and distribution of flow pressure and intensity in hydraulic systems (hydraulic devices).	
Learning outcomes	See **TABLE No 26**	
Form of classes and their duration	Lecture	30
	Practicals	15
	Laboratory	-
	Project	-

Learning content	**Lecture:** 1. Organizational matters. Basic terms in fluid mechanics. Fluid as a continuous material medium. Methods of mathematical description of continuous mediums. Physical fields. 2. State of stresses. Distribution of strain tensor Pascal hypothesis; exercise. Resultant force and moment of force acting on fluid filling an area. Fluid balance principle. 3. Revision from mathematics in the field of vector analysis. Spatial and temporal derivative. Gauss-Ostrogradski Law, Stokes Law. 4. Problem of fluid statics and its analysis. Barotropic fluid and its characteristics. Gas and fluid. Fluid balance in gravitational field. Hydrostatic pressure on the surface. Hydrostatic lift (Archimedes Law). Float steadiness. 5. Discussing tasks from the test. Fluid kinematics. Lagrange's and Euler's description. Velocity field. Velocity field tensor and its distribution. 6. Geometrical illustration of velocity field. Line of current. Pipe of current and stream. Vortex field. Potential flow. Flow stream through a surface. Vortex flow. 7. Material derivative, Convection current. Additive physical values. Law of maintaining additive physical values. Law of maintaining energy and mass. 8. Fluid dynamics. Change in fluid filling an area momentum and resulting force acting on the fluid. Change in moment of momentum of fluid in an area and resulting moment of forces acting on the fluid. Newton's second law for fluid. Euler equation. Dynamic equations of inviscid fluid. 9. Dynamics equation in the form of Lamb-Gromeka. Assumptions connected with Bernoulli flow. Bernoulli equation. An example of formulating and applying the Bernoulli equation. Measuring devices. Vortex movement of fluid. 10. Basics for gas dynamics. Bernoulli law for gas. Gas flow among tanks through Bendeman nozzle. Flow through de Lavale nozzle. Outflow from a tank with a finite volume. 11. Established flows. Change in momentum and moment of momentum during established flow. Continuity equation. Effect of fluid on hydraulic wires. 12. Fluid viscosity. Tensor of deformation speed and its distribution. Newton and Navier hypotheses. Strain tensor related to viscosity. Equation of viscous fluid dynamics. Navier-Stokes equations. 13. One-dimensional flow of viscous fluid. Reynolds experiment and number. Rules and criteria of similarity and their use in fluid mechanics. 14. Resistance of viscous fluid flow through a smooth and rough pipeline. Local flow resistances. Bernoulli equation for the flow of viscous fluid. Description of fluid flow in hydraulic network. 15. Discussing tasks from the test. DISAlacement and rotary hydraulic machines. Balance of moment of momentum in rotary machines. Euler formula. **Practicals:** 1. Fluid properties, Pascal law, manometric formula. 2. Equipotential surfaces, pressure distribution in fluid. 3. Fluid pressure on flat and curved walls of solids. 4. Object floating and stability criteria for floating objects. 5. Application of Bernoulli equation, fluid outflow time from a tank. 6. Suction activity of stream, devices to measure flow velocity. 7. Establishing reaction of flow stream. 8. Energy losses in laminar and turbulent fluid flow, piezometric graph and energy graph. 9. Cooperation between wire and pump, flows through branching wires.
Evaluation methods	Lecture - 2 tests.

	Practicals - 2 tests.
Ways of verifying learning outcomes	See **TABLE No 26**
Exam	No
D. Student's contribution	
Number of ECTS points	3
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours - 48, including: a) lecture - 30 h; b) practicals - 15 h. c) consultation – 3h; 2) Student's own work - 27 a) 5 h – student's current preparation for practicals, literature study, b) 5 h – current preparation of materials connected with lectures, literature study, c) 8 h – student's preparation for 2 tests from lectures, d) 9 h – student's preparation for 2 tests from practicals, 3) TOTAL – 75 h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,92 ECTS points – number of contact hours - 48, including: a) lecture - 30 h; b) practicals – 15 h; c) consultation – 3h;
Number of ECTS points obtained by a student within practical classes:	-
E. Additional information	
Comments	-

TABLE No 26. SUBJECT OUTCOMES	
Knowledge	
Outcome:	A student knows rules for mechanics which are the basis for formulating issues connected with fluid mechanics.
Code:	1150-MT00-ISA-0206_W01
Verification:	Written test
Connected field of study outcomes	K_W03
Outcome:	A student knows methodology of formulating detailed mechanics problems.
Code:	1150-MT00-ISA-0206_W02
Verification:	Written test
Connected field of study outcomes	K_W03
Outcome:	A student knows methods of applying to solving fluid mechanics problems.
Code:	1150-MT00-ISA-0206_W13
Verification:	Written test
Connected field of study outcomes	K_W16
Outcome:	A student knows methods of solving problems related to implementing the phenomena of fluid mechanics.
Code:	1150-MT00-ISA-0206_W04
Verification:	Written test
Connected field of study outcomes	K_W01

Skills	
Outcome:	A student has skills to use theoretical knowledge to solve simple engineering problems in the field of hydraulics.
Code:	1150-MT00-ISA-0206_U01
Verification:	Written test
Connected field of study outcomes	K_U16
Outcome:	A student is ready to obtain new information and their evaluation in the field of hydraulics.
Code:	1150-MT00-ISA-0206_U02
Verification:	Written test
Connected field of study outcomes	K_U19

Description of a Subject		
SUBJECT: ADVANCED GEOMETRY MODELLING		
Subject code	1150-PE000-ISA-0210	
Subject version	Version I	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Compulsory	
Subject level	Basic	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	3	
Pre-requisites	Students must have completed: • Basics of Engineering Drawing and Descriptive Geometry ; • Manufacturing Technology; • Geometry Modeling; • Computer Techniques I.	
Limit of number of students	29	
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Study of the selected methods of parametric 3D modeling systems 3D CAD (meshes from point clouds, surface modeling, modeling of mold or die, sheet metal modeling). Analysis of manufacturability in 3D CAD and CAM systems, programming CNC machines (generating tool paths on free form surfaces for rough and finish milling, virtual machining simulation and analysis of collision)	
Learning outcomes	See **TABLE No 27**	
Form of classes and their duration	Lecture	
	Practicals	
	Laboratory	15
	Project	
Learning content	1. Modeling parts in the context of an assembly (model of mold or die) and generation of the 2D documentation like 3D PDF and 2D files in high quality (300 dpi); 2. Basic techniques of sheet metal modeling in 3D CAD system:	

	creating a base flange, adding a miter flange, adding an edge flange and editing its sketch profile, mirroring a feature, adding and bending a tab, adding a cut across a bend, folding and unfolding bends, creating a closed corner, creating a sheet metal drawing, adding bend line notes. Generating DXF files for workshops and testing their scale in other 2D CAD systems (for example DraftSight). 3. Introduction to surface modeling in 3D CAD system (presentation, examples, explanation of the terms: NURBS, Bezier, Class A surface). Study of surface modeling – lofted surface, extending and trimming, combining with preset tolerance), analysis of surface quality (curvature, zebra stripes, texture mapping) and of connection surface according to: continuity geometry (G0), continuity of tangency (G1) continuity in curvature (G2); demonstration of the continuity of the gradient changes of curvature (G3), information on exporting surface objects by neutral file formats: IGES and STEP, creating solids form surfaces; 4. The analysis of manufacturability shape of the virtual body in 3D CAD systems: generating of milling with solid elements, generating pathways for 3-axis CNC milling (roughing, surface treatments – line printing and profiling), the virtual simulation of manufacturing, collision analysis, surface quality, G-code generation; 5. Introduction to reverse engineering and 3D scanning - examples of application. 3D Scanning of the car body using the measuring system (for example Smarttech ScanBright). Combining and processing of point clouds, generating triangle meshes in 3D CAD systems (Mesh3D, ScanTo3D in SolidWorks). Creating NURBS surface on meshes and analysis of the accuracy of the mapping geometry (eg. SolidWorks ScanTo3D).
Evaluation methods	Each of the 5 exercises is assessed separately on the basis of the individual assignments completed at the end of a class.
Ways of verifying learning outcomes	See **TABLE No 27**
Exam	No
D. Student's contribution	
Number of ECTS points	1
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours- 16, including: a) laboratory - 15 h.; b) consultations - 1 h. 2) Student's individual work 9 hours, including: a) ongoing preparation of the student for laboratory exercises, literature studies – 6 h; b) preparation of reports on completed laboratory exercises – 3 h; 3) TOTAL – sum of individual work and contact hours- 25 h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	0,64 ECTS points – number of contact hours - 16, including: a) laboratory - 15 h.; b) consultations - 1 h
Number of ECTS points obtained by a student within practical classes:	0,96 ECTS points – number of contact hours - 24, including: a) laboratory - 15 h.; b) ongoing preparation of the student for laboratory exercises, literature studies – 6 h; c) preparation of reports on completed laboratory exercises – 3 h;
E. Additional information	
Comments	

TABLE No 27. SUBJECT OUTCOMES

Knowledge	
Outcome:	Student has basic techniques of sheet metal modeling in 3D CAD system. The student has knowledge about modeling and combining surfaces (G0, G1, G2) in 3D CAD system.
Code:	1150-PE000-ISA-0210_W1
Verification:	The individual assignments completed at the end of a class.
Connected field of study outcomes:	K_W05, K_W07
Outcome:	The student has knowledge about the analysis of the technology shape using the tools of the 3D CAD and 3D CAM system and what are the principles of programming roughing (volumetric) milling on CNC machine with end milling tools. The student has a basic knowledge of the principles of using optical 3D scanners and methods of obtaining triangles meshes from point clouds, and then obtaining them from the NURBS surface in a given 3D CAD system
Code:	1150-PE000-ISA-0210_W2
Verification:	The individual assignments completed at the end of a class.
Connected field of study outcomes:	K_W05, K_W07
Outcome:	The student has a basic knowledge of incremental techniques (especially about FDM), knows what it is and how the STL file format is built; knows how the parameters of linear and angular deviation affect the generated triangle mesh from solids; knows what is the influence of inclination of geometry walls on generating support structures in a given 3D CAM system.
Code:	1150-PE000-ISA-0210_W3
Verification:	The individual assignments completed at the end of a class.
Connected field of study outcomes:	K_W05, K_W07
Skills	
Outcome:	The student is able to do a flatten sheet in 3D CAD system.. Student is able to model (in the 3D CAD system) NURBS surfaces connection with G0, G1, G2 continuity.
Code:	1150-PE000-ISA-0210_U1
Verification:	The individual assignments completed at the end of a class.
Connected field of study outcome:	K_U10
Outcome:	The student is able to carry out the analysis of the technology shape using the tools of the 3D CAD and 3D CAM system and can program roughing (volumetric) milling on CNC machine with end milling tools.
Code:	1150-PE000-ISA-0210_U2
Verification:	The individual assignments completed at the end of a class.
Connected field of study outcome:	K_U10
Outcome:	The student is able to do a flatten sheet in 3D CAD system.. Student is able to model (in a given 3D CAD system) a triangles mesh from a point cloud and then get a parametric NURBS surface from them. Student can generate (in a given 3D CAD system) from the solid model a valid STL file for 3D printing and can check (in a given 3D CAM system) to orient it to minimize of support material.
Code:	1150-PE000-ISA-0210_U3
Verification:	The individual assignments completed at the end of a class.

Connected field of study outcome:	K_U10
Social competences	
Outcome:	The student can develop the indicated task and present its result to the lecturer in order to issue the final mark of the given exercise.
Code:	1150-PE000-ISA-0210_K1
Verification:	The individual assignments completed at the end of a class.
Connected field of study outcome:	K_K04

Description of a Subject		
SUBJECT: INTRODUCTION TO MECHATRONICS		
Subject code	1150-PE000-ISA-0390	
Subject version	Version I	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Compulsory	
Subject level	Basic	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	3	
Pre-requisites	Knowledge of the basics of mechatronics, mechanics, electronics and physics is required.	
Limit of number of students	In accordance with the Rector's order	
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	The aim of the subject is to provide knowledge to students in the field of application of mechatronics in industry and everyday life. The lecture and laboratory describe: industrial robots, vehicle control systems, modern toys, advanced household appliances, automation and robotics devices, numerically controlled machine tools, medical equipment, MEMS and MOEMS technologies, measurement areas in the nano range, nanotechnology, optics, IT , micromechanics, multimedia techniques.	
Learning outcomes	See **TABLE No 28**	
Form of classes and their duration	Lecture	15
	Practicals	
	Laboratory	15
	Project	
Learning content	**Lecture:** General knowledge about mechatronic devices and systems. The lecture part consists of, among others from: 1. Initial knowledge (basic concepts): what is mechatronics and what it deals with, 2. Principles of	

	operation, construction and application examples of sensors. 3. The principles of operation, construction and examples of use and actuators. 4. Transmission of information in the vehicle, systems for reading and transmitting information, and numerical codes as information, 5. Numerical systems, logic systems (digital gates), signal analysis, 6. Regulation and regulation systems in mechatronic systems, 7. Energy and its analogies in electric, mechanical, pneumatic and hydraulic systems. **Laboratory:** Practical familiarization with mechatronic systems. 1. Basic elements of hydraulic systems - tests, 2. Control systems - object identification and selection of controller parameters, 3. Use of sensory and executive systems of a mobile robot in Matlab environment, 4. Robot programming in MATLAB language, 5. DSM programming, 6. Model manipulator.
Evaluation methods	Laboratory: Each laboratory exercise is evaluated immediately after its completion. The basis of the assessment is correct performance of the exercise (report) and passing the theoretical part after the exercise. The necessary condition for completing the laboratory is to recover all the exercises provided for in the subject curriculum in the given semester and to pass each exercise at least 3. The final laboratory grade is determined on the basis of the average number of grades obtained from individual exercises covered by the laboratory schedule. The average corresponds to the final evaluation after rounding. Lecture: Completion of the lecture part takes place during the colloquium. In addition, the knowledge gained during classes is verified during laboratory classes by completing the theoretical part, in the case of completing the lab for 4.5 or 5, the student counts the lecture at 3. The student has the opportunity to improve the grade by writing a colloquium. The prerequisite for passing the lecture is passing the colloquium to at least 3. Collective mark: The total mark from the subject is the average of the grades obtained from the laboratory and lecture part. The condition for receiving a positive grade is passing the minimum mark of both parts: laboratory and lecture.
Ways of verifying learning outcomes	See **TABLE No 28**
Exam	No
D. Student's contribution	
Number of ECTS points	2
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours- 32, including: A_ lecture – 15 h; b) laboratory - 15 h.; c) consultations - 2 h. 2) Student's individual work 18 hours, including: a) completing homework assignments - 4 h; b) preparation for classes (including literature studies) - 9 h; c) preparation for the final colloquium: 5 h. 3) TOTAL – sum of individual work and contact hours- 50 h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,28 ECTS points – number of contact hours - 32, including: a) lecture – 15 h; b) laboratory - 15 h.; c) consultations - 2 h
Number of ECTS points obtained by a student within practical classes:	1,12 ECTS points – number of contact hours - 28, including: a) laboratory - 15 h.; b) preparation of a laboratory report – 4 h; c) preparation of classes - 9 h.
E. Additional information	
Comments	

TABLE No 28. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Has knowledge (mathematics, physics) about the construction and principle of operation of mechatronic systems in electric and hybrid vehicles
Code:	1150-PE000-ISA-0390_W1
Verification:	Discussion at the lecture, colloquium
Connected field of study outcomes:	K_W01
Outcome:	Has knowledge about the methods of diagnostics of sensors and actuators in mechatronics of vehicles, is familiar with current diagnostic systems of electric and hybrid vehicles Has knowledge that allows the use of sensors in vehicle control and regulation systems
Code:	1150-PE000-ISA-0390_W2
Verification:	Discussion at the lecture, colloquium
Connected field of study outcomes:	K_W19
Outcome:	Has the basic knowledge necessary to understand non-technical conditions of engineering activities; knows the basic principles of safety and health at work in the automotive industry
Code:	1150-PE000-ISA-0390_W3
Verification:	Discussion at the lecture, colloquium
Connected field of study outcomes:	K_W21
Skills	
Outcome:	Can acquire the right knowledge in order to get information about the correct operation of mechatronic systems
Code:	1150-PE000-ISA-0390_U1
Verification:	Discussion in the laboratory, oral test before admission to perform exercises, performance of the report, passing the colloquium
Connected field of study outcome:	K_U06
Outcome:	Can use the acquired knowledge from the analysis of signals and numerical codes to use diagnostic software to analyze the state of components and systems in the vehicle due to the utility and economic criteria.
Code:	1150-PE000-ISA-0390_U1
Verification:	Discussion in the laboratory, oral test before admission to perform exercises, performance of the report, passing the colloquium
Connected field of study outcome:	K_U11, K_U20
Outcome:	Is able to carry out diagnostics of sensors used in vehicles and determine their impact on the environmental hazard and formulate the specification of simple mechatronic systems
Code:	1150-PE000-ISA-0390_U1
Verification:	Discussion in the laboratory, oral test before admission to perform exercises, performance of the report, passing the colloquium
Connected field of study outcome:	K_U13, K_U14
Social competences	
Outcome:	He can work individually and in a team. He can develop and present a report on his work. He is aware of the benefits of acquaintance and development of mechatronics.
Code:	1150-PE000-ISA-0390_K1

Verification:	The individual assignments completed at the end of a class.
Connected field of study outcome:	K_K02, K_K04

Description of a Subject		
SUBJECT: INTRODUCTION TO MICROPROCESOR SYSTEMS		
Subject code	1150-00000-ISA-0390	
Subject version	Version I	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Compulsory	
Subject level	Basic	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	3	
Pre-requisites	Basic knowledge of the C programming language.	
Limit of number of students	In accordance with the Rector's order	
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	The aim of the course is to learn the principles of programming and software architecture of controllers used in mechatronic systems.	
Learning outcomes	See **TABLE No 29**	
Form of classes and their duration	Lecture	15
	Practicals	
	Laboratory	15
	Project	
Learning content	**Lecture:** Selected microprocessor architectures. Principle of operation and programming of microprocessor systems. Counter systems in embedded systems. Work with A / C and C / A converters and analog peripherals. Communication ports UART, CAN. Creating simple user interfaces. Modern tools supporting the work of a programmer. **Lab:** Programming environment and hardware - introduction to tools. Microcontroller configuration - introduction to work on registers. I / O ports. Counters. Communication ports. A / C converters. Introduction to interrupts.	
Evaluation methods	Lecture: Marks obtained for computer programs (homework) and / or tests. Laboratory: Examination of knowledge in form of a short test before each exercise, evaluation of the quality of software written during classes. The final grade from the laboratory is the average grade for all exercises. Overall mark: average mark from lecture and laboratory	
Ways of verifying learning outcomes	See **TABLE No 29**	
Exam	No	
D. Student's contribution		
Number of ECTS points	2	
Number of hours of	1) Number of contact hours- 32, including:	

student's work connected with achieving learning outcomes:	A_ lecture – 15 h; b) laboratory - 15 h.; c) consultations - 2 h. 2) Student's individual work 19 hours, including: a) completing homework assignments - 4 h; b) preparation for classes (including literature studies) - 10 h; c) preparation for the final colloquium: 5 h. 3) TOTAL – sum of individual work and contact hours- 51 h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,28 ECTS points – number of contact hours - 32, including: a) lecture – 15 h; b) laboratory - 15 h.; c) consultations - 2 h
Number of ECTS points obtained by a student within practical classes:	1,2 ECTS points – number of contact hours - 30, including: a) laboratory - 15 h.; b) preparation of a laboratory report – 5 h; c) preparation of classes - 10 h.
E. Additional information	
Comments	

TABLE No 29. SUBJECT OUTCOMES	
Knowledge	
Outcome:	The student has a basic knowledge of the components of the microcontroller
Code:	1150-00000-ISA-0390_W1
Verification:	Verification of knowledge takes place in writing by answering the question posed. Verification of knowledge is also carried out in writing at the beginning of each laboratory exercise, where the student must solve the task assigned to him.
Connected field of study outcomes:	K_W06
Outcome:	The student understands the essence of the microcontroller's operation and the flow of information in it.
Code:	1150-00000-ISA-0390_W2
Verification:	Verification of knowledge takes place in writing by answering the question posed. Verification of knowledge is also carried out in writing at the beginning of each laboratory exercise, where the student must solve the task assigned to him.
Connected field of study outcomes:	K_W06
Outcome:	The student has a basic knowledge of engineering tools for programming.
Code:	1150-00000-ISA-0390_W3
Verification:	Verification of knowledge takes place in writing by answering the question posed. Verification of knowledge is also carried out in writing at the beginning of each laboratory exercise, where the student must solve the task assigned to him.
Connected field of study outcomes:	K_W07
Skills	
Outcome:	The student is able to accomplish the task in the form of a program for a selected peripheral microcontroller module.
Code:	1150-00000-ISA-0390_U1
Verification:	Verification of knowledge takes place in writing by answering the question posed. Verification of knowledge is also carried out in writing at the beginning of each laboratory exercise, where the student must solve the task assigned to him.
Connected field of study outcome:	K_U11, K_U22
Outcome:	The student is able to use selected engineering tools for programming and

	observation of program execution by the microcontroller..
Code:	1150-00000-ISA-0390_U1
Verification:	Verification of knowledge takes place in writing by answering the question posed. Verification of knowledge is also carried out in writing at the beginning of each laboratory exercise, where the student must solve the task assigned to him.
Connected field of study outcome:	K_U07, K_U10
Outcome:	The student can present the results and formulate conclusions from the exercise.
Code:	1150-00000-ISA-0390_U1
Verification:	Verification of knowledge takes place in writing by answering the question posed. Verification of knowledge is also carried out in writing at the beginning of each laboratory exercise, where the student must solve the task assigned to him.
Connected field of study outcome:	K_U04

Description of a Subject		
SUBJECT: INTRODUCTION TO MACHINE DESIGN I		
Subject code	1150-0000-ISA-0211	
Subject version	Version I	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Compulsory	
Subject level	Basic	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	4	
Pre-requisites	Basic knowledge of the following subjects: Mathematics, Descriptive geometry, Construction materials, Technology, Metrology and interchangeability, Mechanics I and II, Strength of materials I, Fundamentals of Automation and Theory of Machines.	
Limit of number of students	According to the WUT Rector's ordinance	
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Understanding the basic construction of elements and assemblies of machines and the principles of their operation. The ability to select elements including safety factors and basic parameters of the drive system and its assemblies for a specific vehicle.	
Learning outcomes	See **TABLE No 30**	
Form of classes and their duration	Lecture	60
	Practicals	
	Laboratory	
	Project	
Learning content	1. General principles of machinery construction. Methods for calculation of strength of machines. Fatigue strength. Safety factors. Allowable stress. 2 The machinery joints. Threaded joints - types of threads and screws. Efficiency.	

	Self-locking. Calculations of strength bolts and nuts. Buckling. Shape joints - designs and calculations dovetailer, wedge, spline and polygonal. Connections and press- systolic - design and calculation. Welded joints - the technology implementation, design recommendations. Strength calculations joints. Joints welded, soldered and glued, riveted - examples of design solutions, strength calculations. 3 Shafts and axles. Strength calculation of shafts and axles. Static and dynamic rigidity shafts. 4 Rolling and sliding bearings. Principles of bearing. Bearing materials. The calculation and selection of rolling bearings. Friction and lubrication. Hydrodynamic lubrication theory. Lubricants and their properties. Calculation of bearings . 5 Resilient joints. Types and characteristics of the springs. The materials used for making springs. Calculation of the springs. Torsion bars. Springs. 6 Clutches. Classification and load. Rigid and flexible couplings, self-adjusting clutches, universal joints. Friction clutches. Calculation of the main dimensions of the friction clutches . Electromagnetic clutches, hydrodynamic couplings. overload protection clutches, way clutches. 7 Friction brakes. Shoe brakes, disk brakes, jaw and belt brakes. Strength calculation and design recommendations. 8 Kinematics of gear. Basic concepts of geometry and kinematics of meshing. Outline of the involute. The spur and helical gears . Basic concepts of geometry and kinematics of meshing. The review of gears production methods. Fundamentals of the theory of planetary gears. Determination of gear ratios in planetary gears. Worm gears. 9 Kinematics of chain, belt and friction drives. Slip, power, and the efficiency of the friction drives.
Evaluation methods	Written and oral exam.
Ways of verifying learning outcomes	See **TABLE No 30**
Exam	Yes
D. Student's contribution	
Number of ECTS points	4
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours- 63, including: a) lecture - 60 h.; b) consultations - 3 h 2) Student's individual work 40 hours, including: a) student's current preparation for lectures, literature study – 25 h; b) student's current preparation for exam – 15 h; 3) TOTAL – sum of individual work and contact hours 103 h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	2,52 ECTS points – number of contact hours - 63, including: a) lecture - 60 h.; b) consultations - 1 h c) exam -– 2 h
Number of ECTS points obtained by a student within practical classes:	
E. Additional information	
Comments	

TABLE No 30. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Can formulate the basic conditions defining the area of good constructions. He understands the need to formulate the optimization task
Code:	1150-0000-ISA-0211_W1
Verification:	Exam.
Connected	K_W01; K_W06; K_W07; K_W17

field of study outcomes:	
Outcome:	Has knowledge about materials used in the construction of machines and their basic mechanical properties.
Code:	1150-0000-ISA-0211_W2
Verification:	Exam.
Connected field of study outcomes:	K_W04; K_W05; K_W09
Outcome:	Has knowledge about methods of calculating strength of machine elements.
Code:	1150-0000-ISA-0211_W3
Verification:	Exam.
Connected field of study outcomes:	K_W01; K_W04; K_W05; K_W11
Outcome:	He knows the rules for determining safety coefficients and stresses acceptable for permanent and variable loads. He knows the division and operating principles of different types of clutches, block brakes, belt and disc brakes He knows the basic concepts of kinematics of gears, chains, belt and friction gears.
Code:	1150-0000-ISA-0211_W4
Verification:	Exam.
Connected field of study outcomes:	K_W01; K_W04; K_W05; K_W06
Outcome:	He knows the connections used in the construction of machines and the mechanism of load transfer.
Code:	1150-0000-ISA-0211_W5
Verification:	Exam.
Connected field of study outcomes:	K_W01; K_W05; K_W06; K_W15
Skills	
Outcome:	Is able to design a simple connection (threaded, shaped, interference, welded, etc.) transferring the given load. He can justify the proportions of connection dimensions.
Code:	1150-0000-ISA-0211_U1
Verification:	Exam.
Connected field of study outcome:	K_U07; K_U09
Outcome:	He can choose the shape of the machine shaft and solve the bearing correctly.
Code:	1150-0000-ISA-0211_U2
Verification:	Exam.
Connected field of study outcome:	K_U07; K_U08; K_U10; K_U11; KU_16
Outcome:	Is able to select rolling bearings and perform basic calculations of plain bearings.
Code:	1150-0000-ISA-0211_U3
Verification:	Exam.
Connected field of study outcome:	K_U07; K_U09; K_U10; K_U16
Outcome:	Is able to calculate the main dimensions of friction clutches and justify the unevenness of

	the angular couplings.
Code:	1150-0000-ISA-0211_U4
Verification:	Exam.
Connected field of study outcome:	K_U07; K_U09; K_U16
Outcome:	Can justify the shape of metal springs.
Code:	1150-0000-ISA-0211_U5
Verification:	Exam.
Connected field of study outcome:	K_U07; K_U09; K_U10; K_U16
Social competences	
Outcome:	The student is aware of the desirability of constructing safe and user-friendly machines.
Code:	1150-0000-ISA-0211_K1
Verification:	Based on the results of work in the laboratory, evaluation of the report
Connected field of study outcome:	K K_K02; K_K03; K_K04; K_K06

Description of a Subject	
SUBJECT: PROJECT ON MACHINE DESIGN I	
Subject code	1150-00000-ISA-0212
Subject version	Version I
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery
Profile of study	General academic
Degree program	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering
Performing unit	Faculty of Automotive and Construction Machinery Engineering
B. General characteristics of the subject	
Subject kind	Connected with the field of study
Subject group	Compulsory
Subject level	Basic
Subject status	Compulsory
Language of instruction	English
Nominal semester	4
Pre-requisites	Basic knowledge of the following subjects: Mathematics, Descriptive geometry, Construction materials, Technology, Metrology and interchangeability, Mechanics I and II, Strength of materials I, Fundamentals of Automation and Theory of Machines.
Limit of number of students	According to the WUT Rector's ordinance
C. Learning outcomes and the manner of conducting classes	
Aim of the subject	Understanding the principles of operation of screw mechanisms, construction fundamentals, strength calculations and technology of machining elements. Understanding the rules for the application and calculation of connections

	(screw, keyway, bolt, etc.) and the selection of standardized elements. Understanding the general principles of shaping and dimensioning of castings. Understanding the general principles of shaping, dimensioning and strength calculations of welded elements. Ability to design a screw mechanism and simple connections (threaded, shaped, interference, welded, etc.).	
Learning outcomes	See **TABLE No 31**	
Form of classes and their duration	Lecture	
	Practicals	
	Laboratory	
	Project	30
Learning content	1. Examples of screw mechanisms, application and description of their operation. 2. Basic principles of strength calculations for screw mechanisms, the concept of safety factor and permissible stresses. 3. Buckling phenomenon, application in the calculation of screw mechanisms. 4. The force system in the screw-nut pair, the concept of efficiency of the screw mechanism, self-locking of the thread. 5. Interference connection, application of Lame's task. 6. Shaping and dimensioning of cast bodies. 7. Shaping, dimensioning of welded bodies and strength calculations in welded body joints. 8. Ratchet mechanism - principle of operation and calculation of mechanism elements. 9. Key and bolt connections - operating principle, calculations and selection of elements from standards. 10. Discussion of assembly drawings - principles of construction record, elements cooperation, assembly and ergonomics. 11. Discussion of executive drawings - principles of construction record, shaping of elements, the impact of technology.	
Evaluation methods	Evaluation of the project implementation is based on the analysis of the calculation results, correctness of technical drawings (compliance with calculations, design rules and applied subject standards) and on the basis of the knowledge test regarding the area included in the project.	
Ways of verifying learning outcomes	See **TABLE No 31**	
Exam	No	
D. Student's contribution		
Number of ECTS points	2	
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours- 32, including: a) project - 30 h.; b) consultations - 2 h 2) Student's individual work 28 hours, including: a) current preparation of the student for classes – 10 h; b) literature studies - 4 h; c) homework 2 hours; d) calculation and technical documentation - 12 h. 3) TOTAL – sum of individual work and contact hours 60 h.	
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,28 ECTS points – number of contact hours - 32, including: a) project - 30 h.; b) consultations - 2 h	
Number of ECTS points obtained by a student within practical classes:	2,16 ECTS points – number of contact hours - 54, including: a) laboratory – 30 h; b) current preparation of the student for classes – 10 h; c) homework 2 hours; d) calculation and technical documentation - 12 h.	
E. Additional information		
Comments		

TABLE No 31. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Has knowledge about materials used in the construction of machines and their basic mechanical properties. Posiada wiedzę o metodach obliczeń wytrzymałościowych elementów maszyn. He knows the rules for determining safety coefficients and stresses acceptable for permanent and variable loads. He knows the principles of designing simple connections (threaded, shaped, interference, welded, etc.) transferring the given load. Zna zasady projektowania mechanizmów śrubowych.
Code:	1150-00000-ISA-0212_W1
Verification:	Written tests
Connected field of study outcomes:	K_W04, K_W05
Outcome:	He knows the rules for engineering drawing
Code:	1150-00000-ISA-0212_W2
Verification:	Written tests
Connected field of study outcomes:	K_W06
Skills	
Outcome:	Is able to design a simple connection (threaded, shaped, interference, welded, etc.) transferring the given load. He can design a screw mechanism. He is able to properly apply the principles of engineering drawing.
Code:	1150-00000-ISA-0212_U1
Verification:	Project
Connected field of study outcome:	K_U01, K_U06, K_U09
Social competences	
Outcome:	He can do the project task himself.
Code:	1150-00000-ISA-0212_K1
Verification:	Project
Connected field of study outcome:	K_K04, K_K05

Description of a Subject	
SUBJECT: MECHANICAL VIBRATIONS	
Subject code	1150-00000-ISA-0213
Subject version	Version I
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery
Profile of study	General academic
Degree program	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering
Performing unit	Faculty of Automotive and Construction Machinery Engineering
B. General characteristics of the subject	
Subject kind	Connected with the field of study
Subject group	Compulsory
Subject level	Basic
Subject status	Compulsory
Language of instruction	English

Nominal semester	4	
Pre-requisites	Knowledge and skills concerning: - Basic algebra incl. matrices and linear equations, - differential and integral calculus, - differential equations, - complex numbers and their calculus, - principles of mechanics – linear and angular momentum laws, kinetic energy law, - Lagrange equations for multi-body systems, - basic knowledge on strength of materials	
Limit of number of students	According to the WUT Rector's ordinance	
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Understanding the nature and physical sources of vibrations in mechanical systems, incl. excitation and damping of vibrations; modeling and analysis of linear vibrations of discrete and continuous systems; phenomenon of resonance and reducing g resonant amplitudes; knowledge and practical skills in solving simple model problems of vibrations – natural frequencies and eigen-forms in discrete and continuous systems, resonant curves, dynamical vibration absorber, the role of damping; parametric excitation and self-excitation of vibrations.	
Learning outcomes	See **TABLE No 32**	
Form of classes and their duration	Lecture	30
	Practicals	15
	Laboratory	
	Project	
Learning content	Lecture: 1. Introduction (2 hrs) Importance of vibrations in machines and vehicles. Models of vibrating systems and proce4sses. Harmonic motion. Synthesis of harmonic motions. Elements of harmonic analysis. Classification of vibrations. Derivation of equations of motion. 2. Vibrations of single-degree-of-freedom systems (6 hrs) Free vibrations with viscous damping. Logarithmic damping decrement. Vibrations excite4d by harmonic force. Resonance. Amplitude-frequency characteristics. Vibrations under periodic and arbitrary excitations. Impulse transfer function. Kinematically excited vibration. Seismic vibration sensor. Vibroisolation. 3. Analysis of vibrations on the phase plane (4 hrs) Phase plane. Phase trajectory and phase portrait. Singular points. Types of singular points in linear systems and their stability. Płaszczyzna fazowa. Trajektorie fazowe. Obraz fazowy. Separating trajectories in nonlinear systems. Sketching phase portraits. 4. Vibrations of linear multi-degree-of-freedom systems (6 hrs) Free undamped vibrations. Eigenfrequencies. And eigen-forms. General solution of equations of motion. Solution satidfying initial conditions. Damped vibrations. Excited vibrations. Resonant curves. Dynamic vibration absorber. 5. Vibrations of one-dimensional linear continuous systems (6 hrs) Equations of motion of a string, rod, shaft and beam. Initial and boundary problems. Initial and boundary conditions. Eigennumbers, eigen-functions and eigen-frequencies. Orthogonality conditions of eigen-functions. Free vibrations. Vibrations excited by distributed timedependent loads. Kinematically excited vibrations. Rayleigh method of determining approximate eigen-frequencies of continuous systems. 6. Analysis of vibrations of nonlinear systems (4 hrs) Linearization methods. Galerkin method. Properties of nonlinear free vibrations. Damping with dry friction. Nonlinear vibrations under harmonic excitation. Resonance in nonlinear systems. 7. Linear parametric equations (2 hrs) Nature and technical importance of parametric vibrations. Hill and Mathieu equations. Phenomenon of parametric resonance. Solution of Mathieu equation.. Class exercises 1. Harmonic analysis and synthesis. Spectrum of periodic vibrations. 2. Solving problems of free vibrations of systems with single degree of freedom. 3. Calculations of amplitudes of harmonically excited vibrations. Resonant curves in case of unbalance and kinematical excitations. 4. Interpretation of vibrations on the phase plane. Singular points and sketching phase portraits of linear and nonlinear systems. 5. Analysis of free vibrations of systems with two degrees of freedom. Natural frequencies and eigen-form coefficients. 6.	

	Harmonically forced vibrations. Resonant curves. Dynamic vibration absorber.
Evaluation methods	Practicals: written tests on practical ability to solve simple problems as examples of theory presented within the lecture. Attestation of practicals. Lecture: written examination on skills and knowledge concerning the scope of the course.
Ways of verifying learning outcomes	See **TABLE No 32**
Exam	Yes
D. Student's contribution	
Number of ECTS points	3
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours- 48, including: a) lecture - 30 h.; b) practicals – 15 h; c) consultations - 3 h 2) Student's individual work 27 hours, including: a) student's current preparation for lectures, literature study – 17 h; b) student's current preparation for exam – 10 h; 3) TOTAL – sum of individual work and contact hours 75 h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,92 ECTS points – number of contact hours - 48, including: a) lecture - 30 h.; b) practicals – 15 h; c) consultations - 3 h;
Number of ECTS points obtained by a student within practical classes:	
E. Additional information	
Comments	

TABLE No 32. SUBJECT OUTCOMES	
Knowledge	
Outcome:	The student knows the basic quantities characterizing mechanical vibrations, such as amplitude, frequency and period of vibrations, frequency of oscillations, vibration phase, vibration spectrum, elasticity and damping coefficients, etc. and concepts such as vibration damping, amplitude-frequency characteristics, resonance, free vibrations, forced, parametric and self-excited, shock absorption and vibration registration.
Code:	1150-00000-ISA-0213_W1
Verification:	Exam, tests at practicals
Connected field of study outcomes:	K_W01, K_W03
Outcome:	Student is able to build models of vibrating systems for the needs of formulated tasks. Student is able to solve vibration equations of linear systems with many degrees of freedom and one-dimensional continuous systems and interpret the obtained solutions.
Code:	1150-00000-ISA-0213_W2
Verification:	Exam, written tests on practicals, assessment of housework
Connected field of study outcomes:	K_W01, K_W03
Outcome:	Student is able to explain the phenomena occurring in vibrations, such as resonance, vibration damping, force and kinematic excitation, parametric excitation and self-excitation, and understands their importance in technology. The student understands the essence of non-linearities of vibrating systems and their origin, knows the basic properties of non-linear vibrations and methods of their

	analysis.
Code:	1150-00000-ISA-0213_W3
Verification:	Exam.
Connected field of study outcomes:	K_W01, K_W03
Skills	
Outcome:	Student is able to choose the right model of the vibrating system and apply the appropriate method of solving the set task. The student is able to assess the correctness of the obtained result in terms of quantity and quality.
Code:	1150-00000-ISA-0213_U1
Verification:	Exam, written tests, assessment of homework assignments.
Connected field of study outcome:	K_U01, K_U03
Outcome:	The student is able to calculate the frequency of free vibrations of linear systems with many degrees of freedom without suppression, determine the forms of natural vibrations and build a solution of equations of motion that meet any initial conditions. Student is able to determine the amplitudes of vibrations of linear systems with many degrees of freedom at harmonic excitations and analyze their resonant curves. The student knows the principle of operation and is able to choose the parameters of the dynamic vibration eliminator.
Code:	1150-00000-ISA-0213_U2
Verification:	Exam, written tests, assessment of homework assignments.
Connected field of study outcome:	K_U01, K_U03
Outcome:	The student is able to calculate the frequency of natural vibration, determine its own functions and build a solution to the free vibration equation of the string, rod, shaft and beam. Student is able to analyze forced vibrations of strings, rods, shafts and beams during harmonic force - force and kinematic.
Code:	1150-00000-ISA-0213_U3
Verification:	Exam, written tests, assessment of homework assignments.
Connected field of study outcome:	K_U01, K_U03
Outcome:	The student can acquire information about the content of the subject from literature and online databases
Code:	1150-00000-ISA-0213_U4
Verification:	Exam, written tests, assessment of homework assignments.
Connected field of study outcome:	K_U01

Description of a Subject	
SUBJECT: THERMODYNAMICS	
Subject code	1150-MT000-ISA-0214
Subject version	Version I
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery
Profile of study	General academic

Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Basic	
Subject group	Thermodynamics	
Subject level	Intermediate	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	IV	
Pre-requisites	Basic knowledge of physics and chemistry from secondary school.	
Limit of number of students	Maximum number of 30 people in a group (classes)	
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Learning technical problems based on laws of thermodynamics. Ability to apply thermodynamics to describe physical phenomena and mathematical modelling of heat exchange in technological processes. Awareness of requirements and limitations in engineering actions.	
Learning outcomes	See **TABLE No 33**	
Form of classes and their duration	Lecture	30
	Classes	15
	Laboratory	-
	Project	-
Learning content	**Lecture:** Introduction to thermodynamics. Basic terms and definitions: energy, entropy, thermodynamic system, thermodynamic parameters, notion of system state and thermodynamic balance. Units used in thermodynamics, zeroth law of thermodynamics. Microscopic forms of energy, internal energy as a total effect of movement and particle interaction. Basic axioms of thermodynamics. Work and heat as means of energy transfer between systems. I law of thermodynamics for closed systems. Specific heat, enthalpy, ideal gas state equation, characteristic transformations. Perfect gas mixtures and Dalton's law. Real gases, real gas state equations (p-v-T), van der Waals' equation. I law of thermodynamics for open systems. Definition of entropy, properties of entropy, reversible and irreversible transformations, entropy as a function of state. II law of thermodynamics, thermodynamic definition of temperature. Examples of thermodynamic cycles; Carnot cycle, cycle efficiency, examples of engine cycles. Efficiency of engine cycles. Refrigerating cycle. Reciprocating compressors. Unconventional sources of energy. Basic information on heat exchange, mechanisms of heat exchange, conduction, convection, radiation, complex heat exchange (penetration), characteristic numbers, ways of establishing heat transfer coefficient. Basic information on combustion process. **Tutorials**: Laws for ideal gases. Ideal gas mixtures. Specific heat of gases. I law of thermodynamics. Characteristic transformations. Carnot cycle. Otto cycle, Sabathe cycle. Non-characteristic cycles. Comparison of theoretical cycles. Indicator graph.	
Evaluation methods	3 tests (tutorials), exam (lecture).	
Ways of verifying learning outcomes	See **TABLE No 33**	
Exam	Yes	
D. Student's contribution		
Number of ECTS points	3	
Number of hours of student's work connected with achieving learning	1) Number of contact hours – 48., including: a) lecture –30 h; b) classes –15 h.;	

outcomes:	c) consultations – 3 h.; 2) Student's individual work – 27 hours, including: a) 7 h – current preparation for classes and lectures (literature analysis), b) 5 h – doing homework, c) 10 h – preparation for 3 tests, d) 5 h – preparation for 3 exams. 3) TOTAL – 75.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,92 ECTS points – number of contact hours - 48, including: a) lecture –30 h; b) classes –15 h; c) consultations – 3 h;
Number of ECTS points obtained by a student within practical classes:	
E. Additional information	
Comments	

TABLE No 33. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Knowledge about identify thermodynamic processes in technology and can formulate equations describing these processes.
Code:	1150-00000-IZP-0214_W01
Verification:	lecture – exam, classes – 3 tests.
Connected field of study outcome	K_W01; K_W03
Outcome:	The theoretical knowledge about properties of gases and their mixtures and mathematical dependencies related to them. Knows basic rules of thermodynamics enabling to energetically balance heat processes. Has theoretical knowledge in basic gas transformations and heat engine cycles and knows graphs which characterize them (work p-v and heat T-s). Has also knowledge about heat generation processes by means of combustion and heat exchange (conduction, convection, radiation). Has theoretical knowledge about the operation of reciprocating compressor and the graphs which characterize them p-v.
Code:	1150-MT000-ISA-0214_W02
Verification:	Lecture – exam, classes – 3 tests.
Connected field of study outcome	K_W12, K_W17;K_W03
Outcome:	Knowledge about the actual cycle and work processes of a piston combustion engine. Has basic knowledge in basic parameters of its operation.
Code:	1150-MT000-ISA-0214_W03
Verification:	Lecture – exam, classes – 3 tests.
Connected field of study outcome	K_W12, K_W03
Skills	
Outcome:	Knowledge about do basic calculations indispensable for the proper selection of parameters in thermodynamic processes.
Code:	1150-MT000-ISA-0214_U01
Verification:	Lecture – exam, classes – 3 tests.
Connected field of study outcome	K_U03

Description of a Subject		
SUBJECT: LABORATORY OF FLUID MECHANICS		
Subject code	1150-MT000-ISA-0215	
Subject version	Version I	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Basic	
Subject group	Physics and mechanics	
Subject level	Advanced	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	IV	
Pre-requisites	Mathematics: vector analysis and field theory in three-dimensional space. Strength of materials: stress and strain states of material mediums. Fluid mechanics within the scope of lecture and practicals.	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Learning the practical aspects of issues discussed during lectures and practicals, connected with description of physical values characterizing state of fluid and laws describing phenomena occurring in fluids, enabling to establish and analyze hydrostatic strains and distribution of flow pressure and intensity in hydraulic systems (hydraulic devices).	
Learning outcomes	See **TABLE No 34**	
Form of classes and their duration	Lecture	-
	Practicals	-
	Laboratory	15
	Project	-
Learning content	1. Studying fluid viscosity. 2. Establishing reaction of fluid stream. 3. Studying distribution of air velocities in a wire with a circular cross section. 4. Establishing Cx coefficient value for chosen solids. 5. Studying cavitation process. 6. Establishing the values of coefficients of linear and local flow losses.	
Evaluation methods	Evaluating knowledge before starting practicals within the scope of current subject in a written or oral form. Evaluation of an assigned laboratory exercise. Discussion/test based on a prepared report.	
Ways of verifying learning outcomes	See **TABLE No 34**	
Exam	No	
D. Student's contribution		
Number of ECTS points	1	

Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours – 16., including: a) laboratory – 15h; b) consultations – 1h; 2) Student's individual work a) 5 h – current preparation for laboratory b) 5 h – preparing a report. 3) TOTAL – 26 h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	0,64 ECTS point – 16 h ., including: a) laboratory – 15h; b) consultations – 1h
Number of ECTS points obtained by a student within practical classes:	1 ECTS point - 25 h, including 1) laboratory – 15 h. 2) 5 h – preparing for laboratory, 3) 5 h – preparing results, writing a report;
E. Additional information	
Comments	-

TABLE No 34. SUBJECT OUTCOMES	
Knowledge	
Outcome:	A student has knowledge in methods of solving problems related to implementing fluid mechanics phenomena.
Code:	1150-MT000-ISA-0215_W01
Verification:	Laboratory report. Written test/ discussion
Connected field of study outcome	K_W03
Skills	
Outcome:	A student can prepare a report of a solution of a problem related to hydraulics.
Code:	1150-MT000-ISA-0215_U01
Verification:	Laboratory report. Written test/ discussion
Connected field of study outcome	K_U12
Outcome	A student has written and oral skills to present achievements in the field of fluid mechanics.
Code:	1150-MT000-ISA-0215_U02
Verification:	Laboratory report. Written test/ discussion
Connected field of study outcome	K_U02
Outcome:	A student knows how to individually acquire knowledge in the field of hydraulics.
Code:	1150-MT000-ISA-0215_U03
Verification:	Laboratory report. Written test/ discussion
Connected field of study outcome	K_U24
Outcome:	A student can measure and perform computer simulation in the field of fluid mechanics.
Code:	1150-MT000-ISA-0215_U4
Verification:	Laboratory report. Written test/ discussion
Connected field of study outcome	K_U13

Social Competences	
Outcome:	Can think and act in an entrepreneurial way.
Code:	1150-MT000-ISA-0215_K01
Verification:	Laboratory report. Written test/ discussion
Connected field of study outcome	K_K05
Outcome:	Can work in a group perfoming measuring tasks and preparing a report
Code:	1150-MT000-ISA-0215_K02
Verification:	Laboratory report.
Connected field of study outcome	K_K04

Description of a Subject		
SUBJECT: DYNAMIC MEASUREMENT OF MECHANICAL QUANTITIES		
Subject code	1150-MT000-ISA-0216	
Subject version		
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program	–	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Measuring dynamic values	
Subject level	Basic	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	4	
Pre-requisites	Basic knowledge from the subjects: Analysis I and II, Mechanics, especially: sets, functions, function derivatives, indefinite integrals, non-composite numbers and trigonometry.	
Limit of number of students	–	
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Gaining knowledge in methods and techniques of measuring dynamic values occurring in machine construction and basic knowledge in methods and techniques of analysis and processing signals. Learning about methods of signal analysis in the scope necessary to understand application subjects (e.g. machine diagnostics, vibrations and noise reduction etc.). Obtaining skills to select useful information on an observed dynamic system to perform a given task (diagnostics, norm evaluation, model identification etc.) and based on this to select the proper methods of signal processing.	
Learning outcomes	See **TABLE No 35**	
Form of classes and their duration	Lecture	30
	Practicals	–
	Laboratory	–
	Project	–
Learning content	1. Basic terms: definition of measurement, definition of dynamic variable measurement; mathematical record of basic definitions; notion of metrics,	

	norm, measure, metric space; examples of metrics. 2. Measuring system: registration as information transmission, measurement path as information processing, change in information carrier; measurement transducers: of acceleration, speed, dISAlacement, acoustic pressure, temperature, deformation etc. 3. General characteristics of measurement path, linear postulate; description of measurement path from a transducer to analyzing system; drawing conclusions based on intermediate measurements; scaling of a measurement path; functional scales, relative logarithmic scale (dB). 4. Randomization of obtained information; elements of basic definitions of randomization processed and their properties – a generic example. 5. Classification of observed signals; determined - random signals, intermittent - non-intermittent signals, stationary - non-stationary etc. Randomization of measurement as an element accompanying each measurement activity, notion of an estimate. 6. Basic characteristics of random signals in the scope of time: average value, mean square value, effective value, functions of own and reciprocal correlation, standard deviation. 7. Basic characteristics of random signals in the scope of amplitude: distribution of density of amplitude probability, distribuant. 8. Models of determined signals: intermittent signals (harmonic and poli-harmonic), non-intermittent signals, quasi intermittent signals, transition signal (non specified). 9. Introduction to frequency analysis: Fourier series (trigonometric and expotential forms), Fourier Transform: straight and reverse. 10. Fourier Transform of random signal, power spectral density, dependence between power spectral density and correlation function, Parseval theorem. 11. 'Gating' and signal filtration, Borel theorem 12. Signal filtration: filter characteristics (impulse response), description of characteristics in a linear scale of values (amplification factor), description of characteristics in a relative scale and constant relative width of band (in decibels), attenuating signals in rejection band of filters; 13. Division of filters due to operation band, band filters with a constant band width and constant relative band width, using band filters; frequency characteristics of randomized signals: 'white' noise and 'pink' noise. 14. Digital processing of real signals; problem of finite registration time, signal sampling, Shannon theorem on sampling, aliasing, mistakes in spectral analysis due to sampling, quantization of signal amplitudes. 15. Discreet (DFT) and fast (FFT) Fourier Transfor, examples of analysis. 16. Measurements and analysis of input-output relations, coherent analysis, system transmittance, amplification factor; 17. Coherence functions: the influence of input signal noise interference on values of established system transmittances, influence of output signal

	noise interference on values of established system transmittances.
Evaluation methods	Written exam
Ways of verifying learning outcomes	See **TABLE No 35**
Exam	Yes
D. Student's contribution	
Number of ECTS points	2
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours – 32 h, including: a) lecture – 30 h.; b) consultations – 2 h.; 2) Student's individual work – 18 hours, including: a) 5 h – current preparation for a lecture, b) 5 h – literature study, c) 8 h – preparation for exam. 3) TOTAL – 50 h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,28 ECTS points – number of contact hours – 32 h, including: a) lecture – 30 h; b) consultations– 2 h;
Number of ECTS points obtained by a student within practical classes:	-
E. Additional information	
Comments	–

TABLE No 35. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Knows methods and techniques of measuring dynamic quantities occurring in machine construction (dISAlacements, velocities, accelerations, strains etc.)
Code:	1150-MT000-ISA-0216_W1
Verification:	Exam
Connected field of study outcome	K_W02, K_W15
Outcome:	Knows basic methods and techniques of signal analysis and processing.
Code:	1150-MT000-ISA-0216_W2
Verification:	Exam
Connected field of study outcome	K_W15
Outcome:	Knows methods of signal analysis within the scope necessary to understand application subjects (e.g. Machine Diagnostics, Noise and Vibrations Reduction etc.)
Code:	1150-MT000-ISA-0216_W3
Verification:	Exam
Connected field of study outcome	K_W09, K_W15, K_W20
Skills	
Outcome:	Can select useful information on an observed dynamic system to perform a given task (diagnostics, norm evaluation, model identification etc.) and based on this select proper methods of signal processing.
Code:	1150-MT000-ISA-0216_U1
Verification:	Exam
Connected field of	K_U01, K_U06, K_U08, K_U11, K_U16

study outcome	
Social Competences	
Outcome:	Can establish and study influence of machine and devices on human surroundings and natural environment.
Code:	1150-MT000-ISA-0216_K1
Verification:	Exam
Connected field of study outcome	K_K02, K_K05

Description of a Subject		
SUBJECT: SOFTWARE ENGINEERING		
Subject code	1150-PE000-ISA-0352	
Subject version	Version I	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Compulsory	
Subject level	Basic	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	4	
Pre-requisites	Basic knowledge of microprocessor and computer programming languages (C and Matlab). Basic knowledge of microprocessor systems (course Introduction to Microprocessor Systems). Basic knowledge of the description of algorithms and construction of block diagrams.	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Ability to build control and measurements applications in the Windows environment as well as on the real-time systems. Obtaining basic knowledge of networking (CAN and Ethernet). Obtaining basic knowledge of programming controllers including software architectures, networking and data acquisition.	
Learning outcomes	See **TABLE No 36**	
Form of classes and their duration	Lecture	
	Practicals	
	Laboratory	30
	Project	
Learning content	Part I: Introduction to the LabVIEW graphic language programming • Introduction to the LabVIEW environment - programming environment - projects • Basic data structures, operations and graphical presentation of the results • Code implementation (loops, case structures) • Introduction to the modular programming • Programming techniques	

	Part II: Introduction to the control and measurement applications: • basic software architectures, • introduction to the data acquisition systems, • synchronization of the processes, • Internet protocols, • CAN networks.
Evaluation methods	Preparation test for laboratory classes (test at the beginning of classes). Evaluation of the quality of software written during classes. The point score is used: • test - 2 points, • exercise - 3 points To complete the exercise, you need 3 points. The final grade is the average of grades for all exercises (converted from point grades). All exercises are required.
Ways of verifying learning outcomes	See **TABLE No 36**
Exam	No
D. Student's contribution	
Number of ECTS points	2
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours - 32, including; a) laboratory - 30 h; b) consultations – 2 h. 2) Student's individual work - 18 h, including: a) ongoing preparation for laboratory exercises - 18 h; 3) TOTAL – 50.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,28 ECTS points – number of contact hours -32, including: a) laboratory - 30 h; b) consultations – 2 h.
Number of ECTS points obtained by a student within practical classes:	*1,92* ECTS points – number of contact hours -48, including: a) laboratory – 30 h; b) ongoing preparation for exercises - 18 h;
E. Additional information	
Comments	

TABLE No 36. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Has basic knowledge about CAN and Ethernet network programming.
Code:	1150-PE000-ISA-0352_W1
Verification:	Tests checking preparation for classes and the level of assimilation of previous exercises. Evaluation of the quality of the written software.
Connected field of study outcomes:	K_W14
Outcome:	Knows LabVIEW programming language sufficiently to build simple programs for data analysis and exchange
Code:	1150-PE000-ISA-0352_W2
Verification:	Tests checking preparation for classes and the level of assimilation of previous exercises. Evaluation of the quality of the written software.
Connected field of study outcomes:	K_W18
Skills	
Outcome:	Can acquire information from literature, databases and sources, also in English; can integrate the obtained information, make their interpretation and use in the construction of software.

Code:	1150-PE000-ISA-0352_U1
Verification:	Tests checking the preparation for classes and the degree of acquiring knowledge from previous exercises. Evaluation of the quality of written software.
Connected field of study outcome:	K_U01, K_U05
Outcome:	Can independently improve the knowledge gained during programming classes
Code:	1150-PE000-ISA-0352_U2
Verification:	Tests checking the preparation for classes and the degree of acquiring knowledge from previous exercises. Evaluation of the quality of written software.
Connected field of study outcome:	K_U06
Outcome:	Is able to build basic LabVIEW language programs for recording and analyzing signals in accordance with the given specification.
Code:	1150-PE000-ISA-0352_U3
Verification:	Tests checking the preparation for classes and the degree of acquiring knowledge from previous exercises. Evaluation of the quality of written software.
Connected field of study outcome:	K_U08, K_U17, K_U18
Social competences	
Outcome:	Has the ability to work individually and in a team.
Code:	1150-PE000-ISA-0352_K1
Verification:	Evaluation of the task performed during the exercise.
Connected field of study outcome:	K_K01, K_K04, K_K05

Description of a Subject	
SUBJECT: ELECTRONIC CIRCUITS IN CONTROL AND REGULATION SYSTEMS	
Subject code	1150-MT000-ISA-0233
Subject version	Version 1
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery
Profile of study	General academic
Degree program	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering
Performing unit	Faculty of Automotive and Construction Machinery Engineering
B. General characteristics of the subject	
Subject kind	Connected with the field of study
Subject group	Connected with the field of study
Subject level	Intermediate
Subject status	Compulsory
Language of instruction	English
Nominal semester	IV
Pre-requisites	Basic knowledge in electrotechnics, electronics (participating in lectures: Electrical Engineering and Electronics I and II)
Limit of number of students	
C. Learning outcomes and the manner of conducting classes	
Aim of the subject	Learning basic electronic elements and their application in control and regulation systems. Ability to analyze electronic systems. Awareness of requirements and limitations in engineering actions.
Learning outcomes	See **TABLE No 37**

Form of classes and their duration	Lecture	30 h
	Practicals	
	Laboratory	15 h
	Project	
Learning content	Lecture: Intrinsic and extrinsic semiconductors. H-type and P-type semiconductors. Band model of conductors, semiconductors and dielectrics. PN connector and its polarization in the prohibitive and conductive directions. Use of PN connector to build a rectifier diode. Voltage stabilizer using Zener diode. Use of varicap diode as a voltage tuneable capacitor. Tunnel diode and its characteristics with negative resistance area. Varistor and its characteristics and application in surge protectors. Construction and operation of bipolar transistor. Bipolar transistor polarization systems. Establishing transistor amplifier point of operation. Classes of amplifier operation. Amplifier in a common emitter system and its properties. Emitter follower and its properties. Darlington System. Differential amplifier and its properties. Current course. Construction and operation of Field Effect Transistor (FET). Amplifier with FET in a common source system and its properties. Construction and operation of field transistor with isolated MOSFET (Metal Oxide Semiconductor Field Effect Transistor) gate. MOSFET polarization system and establishing point of operation. Performing mathematical operations such as: adding, subtracting, integration, differentiation using operational amplifier. Comparator and Schmitt flip-flop. Feedback – its kinds and application. Influence of negative feedback on amplifier bandwidth. Transistor flip-flops: astable, monostable and bistable. Construction and operation of thyristor. Controlled rectifiers with the use of thyristor. Logic gates and their truth tables. Performing main logic functions by NAND gates. Boole's Theorem. Minimization of logic functions. Number systems: decimal, binary code, Gray's code. Converting numbers from decimal system to binary code and the other way round. Converting binary code into Gray's code and the other way round. RS flip-flop. JK flip-flop. Frequency divider by 2. 4-beat meter Laboratory: Field Effect Transistor. Transistor amplifiers. Transistor flip-flops. Digital gates. 4-beat meter, gates, flip-flops. Operational amplifier, comparator, Schmitt flip-flop.	
Evaluation methods	Lecture: Evaluation based on two written tests – interim and final Laboratory exercise: every exercise is evaluated based on written or oral test, test checking knowledge of a particular exercise and a report on a performed exercise. Final grade is calculated based on average from marks obtained from all exercises, in order to obtain a pass, it is compulsory to obtain passing marks from all exercises. A total grade is calculated based on mark from the lecture (weight 0.65) and mark from laboratory (weight 0.35).	
Ways of verifying learning outcomes	See **TABLE No 37**	
Exam	No	
D. Student's contribution		
Number of ECTS points	3	
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours - 48, including; a) lecture - 30 h; b) laboratory- 15 h; c) consultations – 3 h. 2) Student's individual work - 27 h, including: a) 5 h – literature study;	

	b) 6 h – preparation for classes; c) 6 h – preparing reports; d) 10 h – preparing for tests; 3) TOTAL – 75.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,92 ECTS points – number of contact hours - 48, including: a) lecture - 30 h; b) laboratory- 15 h; c) consultations – 3 h.
Number of ECTS points obtained by a student within practical classes:	1,08 ECTS point – number of contact hours - 27, including: a) 15 h. - laboratory; b) 6 h – preparation for classes; c) 6 h – preparing reports.
E. Additional information	
Comments	

TABLE No 37. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Knows construction and operation of basic electronic elements.
Code:	1150-MT000-ISA-0233_W1
Verification:	Lecture – test, laboratory – written/oral test
Connected field of study outcome	K_W01
Outcome:	Knows rules for establishing and determining electronic element areas of operation based on characteristics.
Code:	1150-MT000-ISA-0233_W2
Verification:	Lecture – test, laboratory – written/oral test
Connected field of study outcome	K_W03
Outcome:	Knows how transistor amplifiers work and knows their characteristics.
Code:	1150-MT000-ISA-0233_W3
Verification:	Lecture – test, laboratory – written/oral test
Connected field of study outcome	K_W03
Outcome:	Lecture – test, laboratory – written/oral test
Code:	1150-MT000-ISA-0233_W4
Verification:	Lecture – test, laboratory – written/oral test
Connected field of study outcome	K_W03
Skills	
Outcome:	Can perform chosen mathematical functions on an operational amplifier.
Code:	T1150-MT000-ISA-0233_U1
Verification:	Test from laboratory exercise.
Connected field of study outcome	K_U12
Outcome:	Can perform chosen logic functions using logic gates.
Code:	1150-MT000-ISA-0233_U2
Verification:	Report from laboratory exercise.
Connected field of study outcome	K_U12
Outcome:	Can minimize logic functions using Boole's laws of algebra and Karnaugh tables.

Code:	1150-MT000-ISA-0233_U3
Verification:	Test, report on laboratory exercise.
Connected field of study outcome	K_U18
Social competences	
Outcomet:	Can cooperate and work as a member of a group while performing laboratory exercises and reports.
Code:	T310_K1
Verification:	Report on laboratory exercise
Connected field of study outcome	K_K04

Description of a Subject		
SUBJECT: MECHATRONICS SENSOR AND ACTUATOR SYSTEMS		
Subject code	1150-00000-ISA-0234	
Subject version	Version I	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Compulsory	
Subject level	Basic	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	4	
Pre-requisites	Knowledge in the field of fundamentals of mechatronics as well as electronics and physics is required.	
Limit of number of students	According to the WUT Rector's ordinance	
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Understanding the construction and operation principles of sensors and actuators used in vehicle mechatronics. Ability to perform measurements and diagnostics of basic mechatronic systems. Awareness of requirements and limitations in engineering practice.	
Learning outcomes	See **TABLE No 38**	
Form of classes and their duration	Lecture	15
	Practicals	
	Laboratory	15
	Project	
Learning content	Lectures: 1. Introduction, inductive and Hall-effect sensors; 2. Potentiometer, thermistor, thermocouple, capacitance, mass flow (hot-wire anemometer) and piezoelectric sensors; 3. Strain gauge and radar and lidar sensors; 4. Photoelectrical (optical) and ultrasound sensors; 5. Electrolytic-resistance and other sensors; 6. Mechanical, electrical and pneumatic actuators; 7. Hydraulic and other actuators. Laboratory classes: 1.Inductive and Hall-effect (rotational speed) sensors 2. Potentiometer and hot-wire (air flow meter) sensors 3. Piezoelectric and MAP 4. Thermistor and electrolytic-resistance	

	(Lambda probe) sensors; 5. Actuators – valves: EGR, vacuum modulation filter regeneration, additional air 6. Actuators – throttling valve with the idle run controller, idle run valves.
Evaluation methods	Lecture: to pass the test on lecture materials the positive mark on the written test should be received. Laboratory: before the beginning of the laboratory class exercise, students have so called "entrance test". Each exercise is evaluated on the basis of a properly prepared report, accepted and evaluated by the supervisor of particular laboratory work.
Ways of verifying learning outcomes	See **TABLE No 38**
Exam	No
D. Student's contribution	
Number of ECTS points	3
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours- 32, including: a) lecture - 15 h.; b) laboratory – 15 h c) consultations - 2 h 2) Student's individual work 43 hours, including: a) student's current preparation for laboratories and lectures, literature study – 18 h; b) student's current preparation for tests – 10 h; c) preparation of reports – 15 h. 3) TOTAL – sum of individual work and contact hours 75 h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,28 ECTS points – number of contact hours - 32, including: a) lecture - 15 h.; b) laboratory – 15 h c) consultations - 2 h
Number of ECTS points obtained by a student within practical classes:	1,2 ECTS points – number of contact hours - 30, including: a) laboratory - 15 h.; n) preparation of reports – 15 h.
E. Additional information	
Comments	

TABLE No 38. SUBJECT OUTCOMES	
	Knowledge
Outcome:	Has knowledge about the construction and operation of mechatronic systems of vehicles.
Code:	1150-00000-ISA-0234_W1
Verification:	Tests
Connected field of study outcomes:	K_W17
Outcome:	Has knowledge about the basics of diagnostics of sensors and actuators in mechatronics of vehicles.
Code:	1150-00000-ISA-0234_W2
Verification:	Colloquium, oral test before admission to exercise, evaluation of reports
Connected field of study outcomes:	K_W09, K_K02
Outcome:	Has knowledge of trends in the development of modern mechatronic systems of vehicles.
Code:	1150-00000-ISA-0234_W3
Verification:	Colloquium, oral test before admission to exercise, evaluation of reports

Connected field of study outcomes:	K_W19
Skills	
Outcome:	Is able to carry out diagnostics of sensors and actuators used in vehicles.
Code:	1150-00000-ISA-0234_U1
Verification:	Oral test before admission to exercise, assessment of reports
Connected field of study outcome:	K_U13, K_U14
Outcome:	Is able to diagnose sensors used in vehicles and determine their impact on the environmental hazard.
Code:	1150-00000-ISA-0234_U2
Verification:	Oral test before admission to exercise, assessment of reports
Connected field of study outcome:	K_U11, K_U20
Social competences	
Outcome:	He can work individually and in a team.
Code:	1150-00000-ISA-0234_K1
Verification:	Assessment of the tasks performed during the implementation of the exercises and evaluation of the report
Connected field of study outcome:	K_K04

Description of a Subject	
SUBJECT: AUTOMATION SYSTEMS	
Subject code	1150-0000-ISA-0235
Subject version	Version I
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery
Profile of study	General academic
Degree program	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering
Performing unit	Faculty of Automotive and Construction Machinery Engineering
B. General characteristics of the subject	
Subject kind	Connected with the field of study
Subject group	Compulsory
Subject level	Basic
Subject status	Compulsory
Language of instruction	English
Nominal semester	4
Pre-requisites	
Limit of number of students	According to the WUT Rector's ordinance
C. Learning outcomes and the manner of conducting classes	
Aim of the subject	A student who completed the course: • has basic knowledge in the field of automatic regulation theory, • has knowledge about the methods used to design automatic control systems, • is able to analyze the obtained results of solved tasks in the field of automatic regulation, • can apply analytical and experimental methods for solving problems to calculate the parameters of automatic control systems, • can identify systems in the field of automatic control of continuous

	processes	
Learning outcomes	See **TABLE No 39**	
Form of classes and their duration	Lecture	15
	Practicals	
	Laboratory	15
	Project	
Learning content	Lecture: Introduction, basic concepts, signals in automation systems, UAR classification transfer characteristics of linear dynamic elements, classification of regulators, regulation algorithms in industrial controllers and programmable controllers, selection of controllers self-tuning and adaptation, sensors automation system, executive components automation system, logic and sequential control , the construction of a digital controller. Laboratory: By laboratory: Identification of the object, selection of controllers' settings, commissioning and testing of a single-circuit control system, testing of regulators, simulation of the feedback system	
Evaluation methods	Lecture: Is passed on the basis of a written exam in the examination session. Laboratory: The preparation of students is checked before the exercise begins. Each exercise is counted on the basis of a properly made report, accepted and evaluated by the person conducting the exercise.	
Ways of verifying learning outcomes	See **TABLE No 39**	
Exam	Yes	
D. Student's contribution		
Number of ECTS points	3	
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours- 32, including: a) lecture - 15 h.; b) laboratory – 15 h c) consultations - 2 h 2) Student's individual work 43 hours, including: a) student's current preparation for laboratories and lectures, literature study – 22 h; b) student's current preparation for exam – 11 h; c) preparation of reports – 10 h. 3) TOTAL – sum of individual work and contact hours 75 h.	
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,28 ECTS points – number of contact hours - 32, including: a) lecture - 15 h.; b) practicals – 15 h c) consultations - 2 h d) exam -– 2 h	
Number of ECTS points obtained by a student within practical classes:	1 ECTS points – number of contact hours - 25, including: a) laboratory - 15 h.; n) preparation of reports – 10 h.	
E. Additional information		
Comments		

TABLE No 39. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Has elementary knowledge in the basics of control and automation, also in the

	application to drive systems of vehicles and work machines
Code:	1150-0000-ISA-0235_W1
Verification:	Verification of student preparation before the beginning of the exercise. Exam.
Connected field of study outcomes:	K_W17, K_W18
kills	
Outcome:	He can build, run and test a designed system or simple mechatronic system
Code:	1150-0000-ISA-0235_U1
Verification:	Assessment of the student's work during the laboratory exercise, evaluation of the report
Connected field of study outcome:	K_U07, K_U12, K_U14
Social competences	
Outcome:	He is aware of the responsibility for his own work and readiness to comply with the principles of teamwork and taking responsibility for the tasks he or she has carried out jointly.
Code:	1150-0000-ISA-0235_K1
Verification:	Based on the results of work in the laboratory, evaluation of the report
Connected field of study outcome:	K_K04

Description of a Subject		
SUBJECT: ELECTRIC POWER TRAINS		
Subject code	1150-MT000-ISA-0301	
Subject version	Version I	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Connected with the field of study	
Subject level	Intermediate	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	V	
Pre-requisites	Basic knowledge in electrical engineering, electronics and electric machines (participating in lectures: Electrical Engineering and Electronics I and II).	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Learning theory of electric power trains of vehicles and construction machinery, basics of construction, solutions, operation and calculation of their systems. Learning to formulate project requirements i.e. selection of kinds and basic parameters of electric power train and its components for a given vehicle and construction machinery type.	
Learning outcomes	See **TABLE No 40**	
Form of classes and their duration	Lecture	15 h
	Practicals	

	Laboratory	15 h
	Project	
Learning content	Lecture: Sources, carriers, transmission of different forms of energy. Track of energy flow from the course to the recipient. Renewable energy sources – discussing available technologies, their advantages and disadvantages. Main energy recipients – energy and traction requirements of means of transport and construction machinery. Energy balance and efficiency of electric power train during driving cycle or operation cycle. Structure of electric power train. Factors influencing the choice of electric engine. Dynamics of electric power train all related issues – dependencies, moment of inertia, kinds and characteristics of resistance moments (including traction), influence of transmission, functions of transmission, reductions of moments, establishing point of operation. Profiles of movement, trajectories, velocity cycles of construction machine. Constant strains and variable strains according to cycles, choice of engine according to medium square strain, choice according to thermal model. Transmission and velocity transducer, precision and repetitiveness of transducer, role of transducer in control processes with feedback, sampling frequency and resolution. Current-voltage transducers working on Hall effect principle. Telemetric torque meters. Electric machines, division, operation principle, main dependencies, construction, characteristics, torque regulation and velocity control, regulation zones and field attenuation, operation in quarters of torque-rotational speed system. Direct current engine controllers, bridge and half-bridge systems, method of PWM impulse width modulation. Control in an open system without feedback, with velocity coupling and velocity-current coupling, hysteresis regulator. Alternating current machines – asynchronous and synchronous – construction, characteristics, torque and velocity control operation regulation, regulation zones and field attenuation, operation in quarters of torque-rotational speed system. Alternating current engine inverters, method of three-phase PWM impulse width modulation, control according to U/f=const. method and vector. Primary and secondary sources of current – review of technologies. Laboratory: Study of asynchronous squirrel-cage engine. Power train with low-speed PM engine. Power train using induction engine controlled by inverter. Study of hydrogen PEM fuel cell. Establishing electric parameters of ultra-capacitors. Study of asynchronous wound rotor engine.	
Evaluation methods	Lecture: written and oral exam, participation in oral exam is contingent on a positive mark from the written part. Laboratory exercise: every exercise is evaluated based on written or oral test, test checking knowledge of a particular exercise and a report on a performed exercise. Final grade is calculated based on average from marks obtained from all exercises, in order to obtain a pass, it is compulsory to obtain passing marks from all exercises. A total grade is calculated based on mark from the lecture (weight 0.65) and mark from laboratory (weight 0.35).	
Ways of verifying learning outcomes	See **TABLE No 40**	
Exam	Yes	
D. Student's contribution		
Number of ECTS points	2	
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours – 32, including: a) lecture -15 h; b) laboratory- 15 h.; c) consultations – 2 h.	

	2) Student's individual work – 18, including a) 5 h – literature study; b) 4 h – preparation for classes; c) 3 h – preparing reports; d) 6 h – preparation for tests and exams; 3) TOATL – 50 hours.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,28 ECTS points – number of contact hours - 32, including: a) lecture -15 h; b) laboratory- 15 h; c) consultations – 2 h;
Number of ECTS points obtained by a student within practical classes:	0,88 ECTS point –22 hours, including: a) 15 h - laboratory; b) 4 h. – preparation for classes; c) 3 h – preparing reports;
E. Additional information	
Comments	

TABLE No 40 . SUBJECT OUTCOMES	
Knowledge	
Outcome:	Has knowledge in the field of electric power train components and their basic qualities.
Code:	1150-MT000-ISA-0301_W1
Verification:	Exam. Test. Report on laboratory exercise.
Connected field of study outcome	K_W02; K_W03; K_W04; K_W05; K_W09; K_W12; K_W17
Outcome:	Knows criteria for choosing components of electric power train, arising from analysis of character of strain and conditions of electric power train operation.
Code:	1150-MT000-ISA-0301_W2
Verification:	Exam. Test.
Connected field of study outcome	K_W02; K_W03; K_W04; K_W05; K_W09; K_W12; K_W17
Outcome:	Knows the rules for establishing and determining traction and operation strains and their effects, indISAensable to design electric power train.
Code:	1150-MT000-ISA-0301_W3
Verification:	Exam. Test. Report on laboratory exercise.
Connected field of study outcome	K_W02; K_W03; K_W04; K_W05; K_W09; K_W12; K_W17
Skills	
Outcome:	Can select particularly strained, in given conditions, components of electric power train and to choose proper component technology considering their estimated costs.
Code:	1150-MT000-ISA-0301_U1
Verification:	Test.
Connected field of study outcome	K_U07; K_U09; K_U13
Outcome:	Can establish characteristics of electric power train components, indISAensable to their proper choice.
Code:	1150-MT000-ISA-0301_U2
Verification:	Test. Report on laboratory exercise.
Connected field of study outcome	K_U12; K_U01
Social competences	

Outcome:	Can cooperate and work as a member of a group while performing laboratory exercises and reports.
Code:	1150-MT000-ISA-0301_K1
Verification:	Report on laboratory exercise.
Connected field of study outcome	K_K04

Description of a Subject		
SUBJECT: INTERNAL COMBUSTION ENGINES		
Subject code	1150-MT000-ISA-0302	
Subject version	Version I	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Connected with the field of study	
Subject level	Advanced	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	V	
Pre-requisites	Mathematics. Chemistry. Physics. Environmental protection. Mechanics. Thermodynamics. Fluid mechanics.	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Learning processes occurring in internal combustion engines. Ability to use the knowledge on the processes occurring in internal combustion engines to construct them, study them and operate them. Awareness of requirements and limitations arising from laws of nature, while constructing, studying, operating internal combustion engines.	
Learning outcomes	See **TABLE No 41**	
Form of classes and their duration	Lecture	30 h
	Practicals	–
	Laboratory	15 h
	Project	–
Learning content	Lecture 1. Introduction. Classification of internal combustion engines. 2. Structural systems of internal combustion engines. 3. Construction systems of internal combustion engines. 4. Heat circulation in internal combustion engines and their basic parameters. 5. Load exchange in piston combustion engines. 6. Mechanics of timing gear system in piston combustion engines. 7. Motor fuels. Classification and properties of motor fuels. 8. Powering piston combustion engines. 9. Combustion in piston combustion engines. Thermochemistry of combustion. Heat production. 10. Energy balance of internal combustion engine.	

	11. Recharging piston combustion engines. 12. Control of piston combustion engines. 13. Piston combustion engine emission of pollution. 14. Characteristics of piston combustion engines. Parameters characterizing internal combustion engines. 15. Methods of studying piston combustion engines in order to evaluate their properties. 16. Mechanics of crankshaft system: kinematics and dynamics of crankshaft system. 17. Balancing of piston combustion engines. Laboratory: 1. Methods of studying internal combustion engines. 2. Speed characteristics of ZI combustion engine. 3. Strain characteristics of ZS combustion engine. 4. Speed characteristics of injection pump. 5. Studies on toxicity of combustion engine fumes and vehicles.
Evaluation methods	Obtaining credit for the lecture is in the form of an exam. Exam covers knowledge and skills obtained within the scope of the subject, covering material from lectures and laboratory. Exam consists of written and oral part. The result of written exam are announced on the day of the exam in a written form after the exam is finished and the exam papers are evaluated by the Subject Coordinator. Final results of the exam are announced to every student after an oral exam. Obtaining credit from the laboratory is based on individual participation in classes, mark from group reports and exercises and mark from individual pass from the material covering knowledge and skills from particular exercises. The final grade is calculated as an average of marks from laboratory pass (weight 0.25) and exam (weight 0.75) on condition that both marks are passing. Otherwise, a student receives a fail.
Ways of verifying learning outcomes	See **TABLE No 41**
Exam	Yes.
D. Student's contribution	
Number of ECTS points	3
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours – 48, including: a) lecture – 30 h; b) laboratory – 15 h.; c) Consultations - 2 h; 2) Student's individual work – 27 h, including: a) 10 h – current preparation for exercises, preparing reports, b) 5 h – literature study, c) 12 h – preparing for exam. 3) TOTAL – 75 h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,92 ECTS points – number of contact hours – 48 including: a) lecture – 30 h; b) laboratory – 15 h; c) consultations - 3 h;
Number of ECTS points obtained by a student within practical classes:	1 ECTS point –25 hours, including: a) class participation – 15 h. b) 10 h of individual work – work on preparation for exercises, preparing reports.
E. Additional information	
Comments	

TABLE No 41. SUBJECT OUTCOMES	
Knowledge	
Outcome:	A student knows processes occurring in internal combustion engines and can evaluate their limitations arising from laws of nature, determining the properties of internal combustion engines and know co-dependencies of internal combustion engines.
Code:	1150-MT000-ISA-0302 W1
Verification:	Exam.
Connected field of study outcome	K_W03, K_W04
Outcome:	A student knows the impact of internal combustion engines on the environment and knows ways of reducing their harmful effects.
Code:	1150-MT000-ISA-0302 W2
Verification:	Exam. Short written/ oral test, evaluation of report.
Connected field of study outcome	K_W03,K_W09
Outcome:	A student knows influence of fuels on properties of internal combustion engines and knows how to influence ecological propertied of internal combustion engines due to knowing fuel properties.
Code:	1150-MT000-ISA-0302 W3
Verification:	Exam.
Connected field of study outcome	K_W03, K_W09
Outcome:	A student knows how to study internal combustion engines in order to evaluate their utility properties as well as knows basic procedures and methods to study internal combustion engines. A student knows how to operate devices to study internal combustion engines.
Code:	1150-MT000-ISA-0302 W4
Verification:	Exam. Short written/ oral test, evaluation of report.
Connected field of study outcome	K_W03, K_W09,K_W15
Outcome:	A student knows strains of construction systems of internal combustion engines.
Code:	1150-MT000-ISA-0302 W5
Verification:	Exam.
Connected field of study outcome	K_W04, K_W05, K_W12
Skills	
Outcome:	A student can critically assess the influence if construction factors on utility properties of internal combustion engines.
Code:	1150-MT000-ISA-0302 U1
Verification:	Exam.
Connected field of study outcome	K_U06, K_U07
Outcome:	A student can evaluate the impact of internal combustion engines on environment and can evaluate effectiveness of ways of reducing their harmful effects.
Code:	1150-MT000-ISA-0302 U2
Verification:	Exam. Short written/ oral test, evaluation of report.
Connected field of study outcome	K_U01, K_U02, K_U03, K_U06, K_U16
Outcome:	A student can evaluate the impact of fuel properties on utility properties of internal combustion engines.
Code:	1150-MT000-ISA-0302 U3
Verification:	Exam. Short written/ oral test, evaluation of report.
Connected field of study outcome	K_U01, K_U02, K_U03, K_U06, K_U16

Outcome:	A student can perform basic study of internal combustion engines and prepare study results.
Code:	1150-MT000-ISA-0302 U4
Verification:	Report evaluation. Evaluation of student's performance during practicals.
Connected field of study outcome	K_U01, K_U02, K_U03, K_U06, K_U16
Social competences	
Outcome:	A student is aware of the importance and of different aspects and results of mechanical engineer's activity, as well as of responsibility for taken decisions.
Code:	1150-MT000-ISA-0302 K1
Verification:	Exam. Short written/ oral test, evaluation of report.
Connected field of study outcome	K_K02
Outcome:	A student is aware of responsibility for individual work and is ready to comply with rules of team work and to take responsibility for commonly performer tasks.
Code:	1150-MT000-ISA-0302 K2
Verification:	Report evaluation. Evaluation of student's performance during practicals.
Connected field of study outcome	K_K04

Description of a Subject	
SUBJECT: PROJECT ON MACHINE DESIGN II	
Subject code	1150-MT000-ISA-0303
Subject version	Version I
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery
Profile of study	General academic
Degree program	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering
Performing unit	Faculty of Automotive and Construction Machinery Engineering
B. General characteristics of the subject	
Subject kind	Connected with the field of study
Subject group	Basic for machine construction
Subject level	Basic
Subject status	Compulsory
Language of instruction	English
Nominal semester	V
Pre-requisites	**BMC Design I**: knowing measure units (mainly SI system) and the ability to calculate them, knowledge (and skills) in calculating, choosing and dimensioning of elements and connections, including e.g. keyway connections, bolted connections and welded connections. **Strength of Materials and Mechanics:** Hooke's Law; regular and tangent strains; expansion, compression, torsion and surface strains; complex state of strains, safety coefficients and fatigue limit; establishing strains and reactions; moments of inertia of sections; coefficients of resistance to bending and twisting; friction. **Basics of Automation and Machine Theory:** kinematics of mechanisms, velocity and acceleration. **Construction Materials, Technology, Metrology and Interchangeability:** construction materials and their application and determination; material constants; production techniques, including mechanical treatment (turning, forging, milling, grinding etc.), heat treatment and heat-chemical treatment;

	basing; roughness of surfaces; tolerance and fitting; dimensional chains; lubrication. **Descriptive Geometry and Basics of Engineering Drawing:** formats, scales, line thickness, technical writing, component specification, drawing economy, projecting, penetrating lines; quads and sections; hatching; drawing of temporary and permanent fastenings; construction and technological dimensioning. **Mathematics:** basic knowledge.	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Application and consolidation and knowledge presented in pre-requisites. Learning rules for chosen power transmission systems (machine shafts, spur and strand transmissions). Learning rules for applying mechanics and strength of materials in calculating rotating elements. Learning chosen rules for element selection according to subject norms. Learning detailed rules for shaping and dimensioning of machine shafts, belt pulleys, gears and chain wheels (including production technologies). Ability to use the above-mentioned issues to construct and create construction documentation.	
Learning outcomes	See **TABLE No 42**	
Form of classes and their duration	Lecture	
	Practicals	
	Laboratory	
	Project	30 h
Learning content	**Machine shaft design:** Discussing materials used for machine shafts (fatigue strength, immediate strength, safety coefficients, determining materials according to PN, DIN, EN and material numbers) Discussing necessary basic calculations for established preliminary assumptions: - Strain analysis, establishing lacking force values; - Establishing support reactions in lateral and vertical surfaces and resultant reactions; - Establishing bending moments in lateral and vertical surfaces and resultant bending moment; - Establishing torque and its possible reduction; - Establishing alternative calculation moment; - Establishing outline of theoretical shaft (safety coefficients in shaft construction). Discussing calculation and selection of normalized dimensions of typical temporary fastenings (keyways, multikeyways) applied in construction of power transmission systems. Discussing chosen rules for selecting rolling bearing and use of catalogues and standards. Discussing shaping of machine shafts: - Preliminary shaping based on theoretical outline, - Shaft shaping with assumed admissible deflections and deflection angles; - Final shaping of a shaft (considering guidelines for bearing avoiding notch operation, avoiding too long retaining pins, considering the influence of applied temporary fastenings on diameters of retaining pins, considering heat treatment and hardness, considering fitting, fastening elements on shafts, introductory phases, transition radii). Discussing requirements for presenting construction (assemblies,	

	subassemblies, typical and atypical elements and normalized and non-normalized elements) in an overall drawing (content drawing) of a machine shaft. Discussing requirements for preparing and executive drawing of a machine shaft (construction and technological bases, bearing and retaining pin tolerances, roughness and hardness of surfaces, shape deviations, regular and threaded center holes, possibilities of applying undercut treatment and outlets and their dimensioning). **Transmission design:** Discussing calculation/choice of strand transmission (according to recommended norms or catalogues) and spur transmission (geometric calculations, selection of chosen parameters of wheels and transmissions from standards and catalogues). Discussing choice of engine and flexible coupling. Discussing rules for strain modelling in the above-mentioned transmissions for the needs of computer selection of shaft geometry. Discussing rules for presenting construction (beltor chain transmission) with a welded support in an overall (content) drawing of a system. Discussing requirements for performing executive drawings of drive wheels for all transmissions, machine shaft and welded support (applied tolerances, roughness and hardness of surfaces, shape deviations and dimensioning od welded fastenings).
Evaluation methods	Continuous assessment consists in checking progress of construction process (calculations, drafts, technical drawings). During classes there are tests and homework (projects) covering at least ten basic issues of the subject.
Ways of verifying learning outcomes	See **TABLE No 42**
Exam	No
D. Student's contribution	
Number of ECTS points	2
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours – 32 h, including: a) project – 30 h; b) consultations – 2 h; *2*) Student's individual work – 18 h, including: a)current preparation for classes– 6 h, b) literature study – 4 h, c) homework – 2 h, d) doing calculations and technical documentation – 6 h. 3) TOTAL – 50 h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,28 ECTS points – number of contact hours – 32 h, including: a) project – 30 h; b) consultations – 2 h;
Number of ECTS points obtained by a student within practical classes:	1,76 ECTS points – 44 h, including: a) project – 30 h; b) current preparation for classes – 6 h, c) homework – 2 h, d) doing calculations and technical documentation – 6 h.
E. Additional information	
Comments	

TABLE No 42. SUBJECT OUTCOMES

Knowledge	
Outcome:	Knows materials used in machine construction and their basic mechanical properties.
Code:	1150-MT000-ISA-0303_W1
Verification:	Written test
Connected field of study outcome e	K_W04, K_W05
Outcome:	Knows different methods of performing strength calculations of machine elements.
Code:	1150-MT000-ISA-0303_W2
Verification:	Written test
Connected field of study outcome	K_W04
Outcome:	Knows rules for determine safety and strain coefficients admissible for constant and variable strains.
Code:	1150-MT000-ISA-0303_W3
Verification:	Written test
Connected field of study outcome	K_W04, K_W06
Outcome:	Knows rules for simple fastenings design bearing a given strain.
Code:	1150-MT000-ISA-0303_W4
Verification:	Written test
Connected field of study outcome	K_W04, K_W05
Outcome:	Knows rules for machine shaft and transmission design.
Code:	1150-MT000-ISA-0303_W5
Verification:	Written test
Connected field of study outcome	K_W04, K_W05, K_W06, K_W10
Outcome:	Knows rules for construction record.
Code:	1150-MT000-ISA-0303_W6
Verification:	Written test
Connected field of study outcome	K_W06
Skills	
Outcome:	Knows how to design simple fastenings design bearing a given strain,
Code:	1150-MT000-ISA-0303_U1
Verification:	Project
Connected field of study outcome	K_U01, K_U06, K_U09
Outcome:	Knows how to design simple elements of power transmission systems.
Code:	1150-MT000-ISA-0303_U2
Verification:	Project
Connected field of study outcome	K_U01, K_U06, K_U09
Outcome:	Knows how to properly apply rules for construction record.
Code:	1150-MT000-ISA-0303_U3
Verification:	Project
Connected field of study outcome	K_U01, K_U06, K_U09
Social Competences	
Outcome:	Can individually perform a project task.
Code:	1150-MT000-ISA-0303_K1
Verification:	Project
Connected field of study	K_K04, K_K05

outcome	

Description of a Subject		
SUBJECT: FUNDAMENTALS OF HYDRAULIC AND PNEUMATIC POWER TRAINS		
Subject code	1150-MT000-ISA-0304	
Subject version	Version I	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Connected with the field of study	
Subject level	Intermediate	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	V	
Pre-requisites	Basic knowledge in fluid mechanics	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Learning rules for design, construction, operation of hydraulic and pneumatic power train systems. Learning to calculate and choose components of hydraulic and pneumatic power trains and their characteristics. Learning to anticipate risks and damages to hydraulic and pneumatic drives.	
Learning outcomes	See **TABLE No 43**	
Form of classes and their duration	Lecture	30 h
	Practicals	-
	Laboratory	15 h
	Project	-
Learning content	**Lecture:** 1. Introductory information. Examples of contemporary application. Classification of hydraulic power trains. Advantages and disadvantages of hydraulic and pneumatic power trains. Hydrostatic and hydrokinetic power train division. Basic parameters of hydrostatic power train. General flowchart of hydrostatic power train. Designation of elements according to PN/ISO-1219-1. Working fluids: functions, properties and requirements, classification and selection of hydraulic fluids. 2. DISAlacement pump. Operation, classification of dISAlacement pumps. Irregularity of dISAlacement pump operation, basic quantities and dependencies. Characteristics of dISAlacement pumps. Overview of solutions. 3. DISAlacement engine. Operation of dISAlacement engines and their classification. Irregularity of dISAlacement engine operation. Basic quantities and dependencies characterizing properties and operation of dISAlacement engine. Reversibility of dISAlacement pump and engine operation. Static characteristics of dISAlacement engines. 4. Hydraulic cylinders. Classification and sample construction solutions of hydraulic cylinders. Basic quantities and dependencies characterizing hydraulic cylinder operation. Braking of piston movement at the end of cylinder stroke. Telescopic and pendulum cylinders – examples of construction	

	solutions. 5. Hydraulic batteries. Battery roles, construction and operation. Protective and locking blocks. Application and selection of batteries in hydraulic systems. 6. Valves. Construction and operation. Functions and classification of valves. Flow controllers and speed synchronizers. Electrohydraulic servo valves and electrohydraulic proportional valves. 7. Hydraulic systems and their control. Kinds of fluid flow and their application. Basic safeguards against hydrostatic system overload. Cooperation of a few pumps. Roles and location of batteries and filters in hydraulic systems. Kinds of control and regulation of dISAlacement machines. Hydrostatic transmissions with constant change of leverage and their characteristics. Hydraulic bridge system (Graetz's system). Application of hydrostatic power train in power train systems of vehicles and construction machinery, advantages and disadvantages. 8. Hydrokinetic power trains. Operation of migratory machines. Hydrokinetic clutches: basic dependencies, dimensionless and dimensional characteristics, cooperation with internal combustion engine. Single-, dual- and multi-range hydrokinetic transmissions, basic dependencies characterizing operation of transmission, dimensionless and dimensional characteristics, transmission permeability, cooperation with internal combustion engine. Hydraulic circuit of oil flow through automatic transmission. Use of hydrokinetic power train in drive track of vehicles and construction machinery – hydro mechanical transmissions – their advantages and disadvantages. 9. Pneumatic power train and pneumatic control. Characteristic elements: power sources, executive and control elements, elements of working factor preparation, assistive. Basic dependencies describing gas flow applied in pneumatic systems. Pneumatic systems. **Laboratory:** Topics of practicals: 1. Control in hydraulic systems with the use of proportional technique. (IMRC), 2. Basic elements of hydraulic systems (IMRC), 3. Precision of hydraulic cylinder piston positioning (IMRC), 4. Basic elements of pneumatic systems (IMRC), 5. Characteristics of dISAlacement pump (IP), 6. Dimensionless characteristics of hydrokinetic transmission (IP), 7. Dimensionless characteristics of hydrostatic transmission (IP), 8. Study of phenomena accompanying the outflow of gas from the tank (IP).
Evaluation methods	**Lecture:** Credit is granted based on an exam. **Laboratory:** Knowledge is checked before starting exercises from the scope of current subjects in a written or oral from. Report on performed laboratory exercise. Discussion – accepting a report on a given exercise. **Rules for calculating final grade:** Student has to obtain a pass from both kinds of subject: Lecture (W) and Laboratory (L). **Final grade** (OŁ): OŁ = (2 x W + L)/ 3
Ways of verifying learning outcomes	See **TABLE No 43**
Exam	Yes

D. Student's contribution	
Number of ECTS points	3
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours - 48, including: a) lecture - 30 h; b) laboratory- 15 h; c) consultations - 3 h; 2) Student's individual work - 42 h including: a) 5 h – current preparation for lecture, b) 5 h –literature study, c) 10 h – preparing for an exam, d) 10 h – current preparation for laboratory, e) 12 h – preparing reports for laboratory. 3) TOTAL – 90 hours.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,92 ECTS points – number of contact hours - 48, including: a) lecture - 30 h; b) laboratory- 15 h; c) consultations - 3 h;
Number of ECTS points obtained by a student within practical classes:	1,48 ECTS points - 37 hours, including 1) laboratory exercises – 15 h; 2) 10 h – preparing for laboratory exercises; 3) 12 h – preparing results and reports.
E. Additional information	
Comments	

TABLE No 43 . SUBJECT OUTCOMES	
Knowledge	
Outcome:	Has knowledge on application and construction of components used in hydraulic and pneumatic power trains.
Code:	1150-MT000-ISA-0304_W1
Verification:	Exam
Connected field of study outcome	K_W17; KW_18; KW_19; KW_20
Outcome:	Has knowledge and skills connected with criteria for choosing components applied in hydraulic and pneumatic power trains, arising from analysis of their potential use.
Code:	1150-MT000-ISA-0304_W2
Verification:	Exam
Connected field of study outcome	K_W17; KW_18; KW_19; KW_20
Outcome:	Can establish strains of particular elements of hydraulic system, necessary for considered operation mode.
Code:	1150-MT000-ISA-0304_W3
Verification:	Exam. Oral / written test before exercises, evaluation of report from laboratory exercises.
Connected field of study outcome	K_W17; KW_18; KW_19; KW_20
Outcome:	Can perform analyses necessary to prove considered project criteria of hydraulic system.
Code:	1150-MT000-ISA-0304_W4
Verification:	Exam. Oral / written test before exercises, evaluation of report from laboratory exercises.
Connected field of	K_W17; KW_18; KW_19; KW_20

study outcome	
Outcome:	Can establish characteristics of components, necessary for considered project criterion.
Code:	1150-MT000-ISA-0304_W5
Verification:	Exam. Oral / written test before exercises, evaluation of report from laboratory exercises.
Connected field of study outcome	K_W17; KW_18; KW_19; KW_20
Skills	
Outcome:	Has knowledge and skill concerning criteria for choosing components used in hydraulic and pneumatic power trains arising from analysis of their potential application.
Code:	1150-MT000-ISA-0304_U1
Verification:	Exam
Connected field of study outcome	K_U07; K_U11; K_U18
Outcome:	Knows rules for establishing and determining operation strains and their effects necessary for proper selection of hydraulic and pneumatic system components.
Code:	1150-MT000-ISA-0304_U2
Verification:	Exam. Oral / written test before exercises, evaluation of report from laboratory exercises.
Connected field of study outcome	K_U01; K_U08; K_U11; K_U15; K_U18
Outcome:	Can anticipate risks of damage to hydraulic system, establish critical points and formulate proper hydraulic system repair criteria.
Code:	1150-MT000-ISA-0304_U3
Verification:	Exam
Connected field of study outcome	K_U09; K_U18; K_U19
Outcome:	Can establish strains of particular elements of hydraulic system, necessary for considered operation mode.
Code:	1150-MT000-ISA-0304_U4
Verification:	Exam. Evaluation of report from laboratory exercises.
Connected field of study outcome	K_U11; K_U12; K_U15
Outcome:	Can perform analyses required to prove considered project criteria of a hydraulic system.
Code:	1150-MT000-ISA-0304_U5
Verification:	Exam. Evaluation of report from laboratory exercises.
Connected field of study outcome	K_U02; K_U07; K_U11; K_U17; K_U19
Outcome:	Can establish component characteristics, indISAensable for analyzed project criterion.
Code:	1150-MT000-ISA-0304_U6
Verification:	Exam. Evaluation of report from laboratory exercises.
Connected field of study outcome	K_U12; K_U16; K_U17
Social Competences	
Outcome:	Can work individually and in a team.
Code:	1150-MT000-ISA-0304_K1
Verification:	Work in a laboratory
Connected field of study outcome	K_K02; K_K04

Description of a Subject		
SUBJECT: VEHICLES		
Subject code	1150-00000-ISA-0309	
Subject version	Version I	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Compulsory	
Subject level	Basic	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	5	
Pre-requisites	Knowledge in the field of general mechanics and vibration theory of mechanical systems	
Limit of number of students	According to the WUT Rector's ordinance	
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Getting to know the theory of car traffic and general knowledge about their construction. The ability to apply the laws of physics to the description of car traffic. Awareness of requirements and limitations in engineering activities.	
Learning outcomes	See **TABLE No 44**	
Form of classes and their duration	Lecture	30
	Practicals	
	Laboratory	15
	Project	
Learning content	Lecture: 1. Car classification. Models of flexible wheel cooperation with rigid surface. Pneumatic tires on road vehicles. The construction and properties of tires 2. Equation of the car's progressive movement. Resistance of car movement. Rolling resistance, air resistance, hill resistance, resistance of inertia. Strength and power of movement resistance 3. Drive sources. Types of engines, characteristics. Balance of strength and power. Adjusting the motor characteristics to the needs of the car's drive. Acceleration graph 4. Equation of delayed traffic. The course of the car stop process. Driver's reaction times. Driving in a column 5. Requirements for the braking process. Braking performance. Changes in axle loads. Braking stability. Diagram of unit braking forces. Distribution of braking forces between axles 6. Kinematics of curvilinear motion. Geometric relations in curvilinear motion. Feedback of maneuverability. The phenomenon of side drift. 7. Dynamics of curvilinear movement. Equation of curvilinear motion. The relationship between the angle of steering of the wheels and the angular speed. Under- and oversteer 8. Steerability tests. Fixed traffic. Transient motion 9. Stability. Critical speed. Turning to the side 10. A model for describing vertical vibrations. Unhitching the vibration of the	

	front and rear of the vehicle. Amplitude and frequency characteristics. 11. Impact of road inequalities. Spectrum inequalities. Impact of vibrations on a human being. Requirements for comfort and safety Lab: 1. Resistance of car movement, dynamic characteristics 2. Testing of vertical vibrations of the vehicle while driving 3. Determination of contact parameters of the wheel-track set 4. Test bench brake 5. Determining the characteristics of tire adhesion 6. Testing of the steering system 7. Testing of brakes on a roller stand
Evaluation methods	Lecture - two tests or homework and colloquium. Laboratory - passing each exercise based on the report and individual assessment of each student. The final grade from the laboratory is determined as the arithmetic mean of individual laboratory exercises. All laboratory exercises must be passed at least on a satisfactory grade. Completion of the course takes place on the basis of credit for both the lecture and the laboratory, and the final grade is calculated as a weighted average of these grades, with the lecture grade being more important.
Ways of verifying learning outcomes	See **TABLE No 44**
Exam	No
D. Student's contribution	
Number of ECTS points	3
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours- 48, including: a) lecture - 30 h.; b) laboratory – 15 h; c) consultations - 3 h 2) Student's individual work 27 hours, including: a) student's current preparation for lectures, literature study – 9 h; b) student's current preparation for test – 8 h; c) ongoing preparation for laboratory exercises -10 h; 3) TOTAL – sum of individual work and contact hours 75 h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,92 ECTS points – number of contact hours 48, including: a) lecture - 30 h.; b) laboratory – 15 h; c) consultations - 3 h
Number of ECTS points obtained by a student within practical classes:	1 ECTS points – number of contact hours -25, including: a) laboratory – 15 h; b) ongoingpreparation for exercises -10 h;
E. Additional information	
Comments	

TABLE No 44. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Has a structured, theoretically founded general knowledge covering key issues in the field of motor vehicle traffic mechanics.
Code:	1150-00000-ISA-0309_W1
Verification:	Written test (colloquium), reports on laboratory exercises completed with an individual assessment of each student.
Connected field of	K_W12, K_W14

study outcomes:	
Outcome:	Has the ordered and theoretically founded knowledge of physics, including the mechanics of the material point and the rigid body in the range necessary to understand the basic physical phenomena occurring in the propulsion systems and structural elements of machines and vehicles
Code:	1150-00000-ISA-0309_W2
Verification:	Written test (colloquium), reports on laboratory exercises completed with an individual assessment of each student.
Connected field of study outcomes:	K_W03, K_W15
Outcome:	Has basic knowledge in the field of measurements of dynamic quantities, methods for the development of measurement results and their interpretation.
Code:	1150-00000-ISA-0309_W3
Verification:	Written test (colloquium), reports on laboratory exercises completed with an individual assessment of each student.
Connected field of study outcomes:	K_W16
Skills	
Outcome:	Is able to use the methods and mathematical, physical and IT models learned to analyze and evaluate the operation of mechanical systems using computer simulations for this purpose.
Code:	1150-00000-ISA-0309_U1
Verification:	Written test (colloquium), reports on laboratory exercises completed with an individual assessment of each student.
Connected field of study outcome:	K_U01
Outcome:	Is able to determine the power demand of the vehicle and is able to select components for drive systems and analyze their functioning.
Code:	1150-00000-ISA-0309_U2
Verification:	Written test (colloquium), reports on laboratory exercises completed with an individual assessment of each student.
Connected field of study outcome:	K_U11
Outcome:	Can use the acquired specialist knowledge in the study and analysis of phenomena occurring in the construction and operation of vehicles.
Code:	1150-00000-ISA-0309_U3
Verification:	Written test (colloquium), reports on laboratory exercises completed with an individual assessment of each student.
Connected field of study outcome:	K_U16
Social competences	
Outcome:	Is aware of the importance and understanding of non-technical aspects and effects of engineering activities, including the problems of car traffic safety and its impact on the environment.
Code:	1150-00000-ISA-0309_K1
Verification:	Written test (colloquium)
Connected field of study outcome:	K_K02
Outcome:	He is aware of the responsibility for his own work and readiness to comply with the principles of teamwork and taking responsibility for the tasks he or she has carried out jointly.
Code:	1150-00000-ISA-0309_K1
Verification:	Reports on laboratory exercises completed with an individual assessment of each student.
Connected field of study outcome:	K_K04

Description of a Subject		
SUBJECT: CONSTRUCTION MACHINERY AND EQUIPMENT		
Subject code	1150-MT000-ISA-0306	
Subject version	Version I	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program	---	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Connected with the field of study	
Subject level	Intermediate	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	5	
Pre-requisites	Basic knowledge in general mechanics, strength of materials, basics for machine construction (participation in lectures: General Mechanics, Strength of Materials, Basics for Machine Construction).	
Limit of number of students	laboratory – groups of 7-12 people, lecture – no limit	
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Learning basic kinds of construction machinery and equipment, their construction and operation. Learning about development trends in the field of construction machinery and equipment. Learning to present functioning schemes of construction machinery and equipment.	
Learning outcomes	See **TABLE No 45**	
Form of classes and their duration	Lecture	30 h
	Practicals	
	Laboratory	15 h
	Project	
Learning content	**Lecture** Classification of construction machinery and equipment: cranes, lifts, construction machinery, road construction machinery, rock processing machinery. Classification and general description of cranes: string cranes, gantry cranes, stacker cranes, hoisting cranes. Gantry cranes. Construction of lifting mechanisms (hoists, gantries). Basic mechanism systems: engine, reducer, brake, rope drum, pulley system, pulley blocks, gripping devices. Kinds of gantry cranes: overhead travelling cranes and suspended overhead travelling cranes, container cranes. Construction and operation. Powering mechanisms and bearing structure of gantry cranes. Container cranes: construction of container gripper, mechanism of lifting container gripper.	

	Stationary cranes: application, construction, operation, powering mechanisms, bearing structure. Crane stability and load capacity characteristics. Self-propelled cranes: slow-speed and high-speed. Application, construction, operation. Powering mechanisms and bearing structure. Load capacity characteristics. Cranes with telescopic arms: construction and operation of the arm, telescopic mechanism, development of arm bearing structure. Transport and reloading cranes: application, construction, characteristics of load capacity. Securing mechanisms in cranes: technical safety precautions, construction, operation of load capacity limiter. Lifts. General construction of electric and hydraulic lifts. Machinery for ground works and their influence on ground mediums and rocks. History of ground works machinery. Construction site - sample technologies of performing tasks. Basics for mining of soils and movement of machinery. Physical properties of soils and rocks. Study of properties of ground mediums and rocks, modelling of ground mediums and rocks – Coulomb model and modified Coloumb's condition. Analysis of chosen mining of ground mediums and rocks processes. Methods of approximate calculations of mining resistances. Mechanics of vehicle-ground system. Overview of basic construction machinery and their construction (excavator, loader, bulldozer, grader, scrapper, machines for densification of soils). Rock mining. Overview of machines and methods of rock mining. Machines for producing aggregates. **Laboratory** Study of tower crane stability. Acceptance study of gantry crane. Interaction between caterpillar system and ground. Rock crushing. Automation of construction machinery on the example of pull shovel. Establishing properties of loose materials.
Evaluation methods	**Subject grade** Obtaining a credit is contingent on receiving pass marks both from laboratory (OL), and from lecture (OW). Final grade is a cumulative grade (O). It is calculated in a following manner: O = 0.6*OW + 0.4*OL, **Lecture** Grade for Lecture is established based on two test results. For each test one can obtain from 0 to 20 marks. In order to obtain credit for Lecture, it is necessary to obtain at least 20 effective marks from two tests. Effective points are calculated according to the formula: PE = 2*P-10, where P is the number of points obtained from a test, when P < 10. When P >=10; PE = P. **Laboratory** A pass grade is obtained after passing a short oral/written test, so called "entry quiz", doing exercises correctly, and obtaining at least 3.0 from the report. In order to pass laboratory it is necessary to obtain pass (at least 3.0) from all exercises. Overall grade is an arithmetical average of marks from all the exercises.
Ways of verifying learning outcomes	See **TABLE No 45**
Exam	No
D. Student's contribution	
Number of ECTS points	3

Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours - 48, including: a) lecture - 30 h; b) laboratory- 15 h; c) consultations – 3 h, 2) Student's individual work - 27 h, including: a) 11 h – current preparation for exercises and lectures (literaturę study); b) 6 h – preparing results and reports; c) 10 h – preparing for 2 tests. 3) TOTAL – 75 h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,92 ECTS points – number of contact hours - 48, including: a) lecture - 30 h; b) laboratory- 15 h; c) consultations – 3 h,
Number of ECTS points obtained by a student within practical classes:	1,08 ECTS point - 27 h, including: 1) laboratory exercises – 15 h., 2) 6 h – preparing for laboratory exercises, 6 h – preparing results and reports.
E. Additional information	
Comments	

TABLE No 45. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Knows different kinds of construction machinery and equipment, their application, construction and development trends.
Code:	1150-MT000-ISA-0306_W1
Verification:	Test
Connected field of study outcome	K_W13, K_W17, K_W19
Outcome:	Knows devices securing construction machinery operation.
Code:	1150-MT000-ISA-0306_W2
Verification:	Test, Evaluation of laboratory exercise report
Connected field of study outcome	K_W15
Skills	
Outcome:	Can compare basic parameters of construction machinery and evaluate machined from different producers.
Code:	1150-MT000-ISA-0306_U1
Verification:	Test
Connected field of study outcome	K_U04
Outcome:	Can present and discuss functional schemes of construction machinery. Can characterize kinds and basic structure of power train systems of construction machinery.
Code:	1150-MT000-ISA-0306_U2
Verification:	Test, Evaluation of laboratory exercise report
Connected field of study outcome	K_U09
Social Competences	

Outcome:	Can work individually and in a group while conducting research and preparing a report.
Code:	1150-MT000-ISA-0306_K1
Verification:	Evaluation of laboratory exercise report
Connected field of study outcome	K_K04

Description of a Subject

SUBJECT: DYNAMIC MEASUREMENT OF MECHANICAL QUANTITIES LABORATORY

Subject code	1150-MT000-ISA-0331	
Subject version	Version I	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Measurement of dynamic quantities	
Subject level	Intermediate	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	V	
Pre-requisites	Basic knowledge on the following subjects: Mathematics, Metrology and interchangeability, General Mechanics I and II, Strength of Materials I and II, Basics of Automation and Machine Theory. Basics of Machine Construction, Theory of Vibrations. Knowledge and skills within the scope of the subject "Measurements of Dynamic Variables" done as a lecture (4th semester) and concluded with an exam.	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Consolidation of knowledge on methods and techniques of mechanical measurements of dynamic variables and on signal processing. Ability to perform measurements of dynamic variables occurring on machine construction.	
Learning outcomes	See **TABLE No 46**	
Form of classes and their duration	Lecture	-
	Practicals	-
	Laboratory	15 h
	Project	-
Learning content	**Laboratory:** Measurements of acoustic pressure. Measurements of machine vibrations. Tensometric measurements of torque. Measurements of torsional vibrations. Basics for spectral analysis.	
Evaluation methods	Before starting an exercise, students' preparation is checked (so called 'entry quiz'). The pass for each exercise is granted based on correctly performed report, accepted and evaluated by the Subject Coordinator.	
Ways of verifying learning outcomes	See **TABLE No 46**	

Exam	No
D. Student's contribution	
Number of ECTS points	1
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours - 16, including a) laboratory – 15 h; b) consultations – 1 h; 2) Student's individual work 15 h, current preparation for exercises 3) TOTAL – 31 h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	0,64 ECTS point – number of contact hours - 16, including a) laboratory – 15 h; b) consultations – 1 h;
Number of ECTS points obtained by a student within practical classes:	1,2 ECTS point – 30 h, including: 1) laboratory exercises – 15 h; 2) 15 h – preparation for laboratory exercises.
E. Additional information	
Comments	

TABELA NR 46. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Knows methods and techniques of measurements of dynamic variables occurring in machine construction (dISAlacement, velocities, accelerations, strains etc.).
Code:	1150-00000-ISA-0331_W1
Verification:	Quiz before admitting to exercises, evaluation of reports.
Connected field of study outcome	K_W02; K_W15
Outcome:	Has basic knowledge on methods and techniques of signal analysis and processing.
Code:	1150-00000-ISA-0331_W2
Verification:	Quiz before admitting to exercises, evaluation of reports.
Connected field of study outcome	K_W02; K_W15
Skills	
Outcome:	Can perform measurements of dynamic variables using modern measuring devices (including calibration of measurement track based on external sample and based on characteristics of measurement track).
Code:	1150-00000-ISA-0331_U1
Verification:	Evaluation of tasks while doing exercises, evaluation of report.
Connected field of study outcome	K_U08; K_U11; K_U12
Outcome:	Can select useful information on an observed dynamic system to perform a given task (diagnostics, norm evaluation, model identification etc.) and based on this choose proper signal processing methods.
Code:	1150-00000-ISA-0331_U2
Verification:	Evaluation of tasks while doing exercises, evaluation of report.
Connected field of study outcome	K_U08; K_U11; K_U12
Social competences	
Outcome:	Can cooperate and work in a team while doing laboratory exercises and while preparing a report, assuming different roles.
Code:	1150-00000-ISA-0331_K1
Verification:	Evaluation of tasks while doing exercises, evaluation of report.
Connected field of study outcome	K_K04

Description of a Subject		
SUBJECT: INTRODUCTION TO IMAGE PROCESSING		
Subject code	1150-00000-ISA-0332	
Subject version	Version I	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Compulsory	
Subject level	Basic	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	5	
Pre-requisites		
Limit of number of students	According to the WUT Rector's ordinance	
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	The introduction of students to basic methods of acquisition and image processing.	
Learning outcomes	See **TABLE No 47**	
Form of classes and their duration	Lecture	15
	Practicals	
	Laboratory	
	Project	
Learning content	Lecture: Introduction to image processing and analysis. Image types. Color space models. Digital representations of images. Image data structures and methods of their conversion. Acquisition of digital images. Spatial and color discretization of analogue images. Changing spatial and color resolution of images. Geometrical transformations of images. Arithmetic and logical transformations of images. Image normalization. Gamma correction of images. Image data histogram. Image histogram equalization. Image binarization.	
Evaluation methods	Lecture: Completion of the course takes place on the basis of a test. A condition necessary to obtain the credit for the subject is achieving at least the minimum pass grade (3) for the test.	
Ways of verifying learning outcomes	See **TABLE No 47**	
Exam	No	
D. Student's contribution		
Number of ECTS points	1	
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours- 16, including: a) lecture - 15 h.; c) consultations - 1 h 2) Student's individual work 15 hours, including: a) student's current preparation for lectures, literature study – 10 h; b) student's current preparation for test – 5 h; 3) TOTAL – sum of individual work and contact hours 31 h.	

Number of ECTS points for classes requiring direct participation of members of academic staff:	0,64 ECTS points – number of contact hours 16, including: a) lecture - 15 h.; c) consultations - 1 h
Number of ECTS points obtained by a student within practical classes:	
E. Additional information	
Comments	

TABLE No 47. SUBJECT OUTCOMES	
Knowledge	
Outcome:	A student who has completed the subject has general knowledge of the principles of image acquisition systems.
Code:	1150-00000-ISA-0332_W1
Verification:	Written test
Connected field of study outcomes:	K_W18
Outcome:	A student who completed the subject has a detailed knowledge of the basic methods of image processing.
Code:	1150-00000-ISA-0332_W2
Verification:	Written test
Connected field of study outcomes:	K_W07

Description of a Subject	
SUBJECT: COMPUTER SYSTEMS IN MECHATRONICS	
Subject code	1150-00000-ISA-0398
Subject version	Version I
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery
Profile of study	General academic
Degree program	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering
Performing unit	Faculty of Automotive and Construction Machinery Engineering
B. General characteristics of the subject	
Subject kind	Connected with the field of study
Subject group	Compulsory
Subject level	Basic
Subject status	Compulsory
Language of instruction	English
Nominal semester	45
Pre-requisites	Basic knowledge of controller programming in C and LabVIEW languages (Software Engineering and Introduction to Microprocessor Systems.
Limit of number of students	
C. Learning outcomes and the manner of conducting classes	
Aim of the subject	Learning the principles of programming and software architecture of controllers used in mechatronic systems.

Learning outcomes	See **TABLE No 48**	
Form of classes and their duration	Lecture	15 h
	Practicals	
	Laboratory	15 h
	Project	
Learning content	**Lecture** Basic knowledge on the registration and analysis of analog and digital signals in real-time systems. The use of I/O systems to support control processes in internal combustion engines. Communication between controllers in the CAN network. **Laboratory** Measurements of physical quantities, synchronization of sensors and actuators while maintaining the rigors of time, implementation of typical tasks in control systems. The use of data exchange networks. Creating graphical user interfaces.	
Evaluation methods	**Lecture** A test to check the degree of material acquisition. Rating on a scale of 2-5. **Laboratory** Preparation test for laboratory classes (test at the beginning of classes). Evaluation of the quality of software written during classes. The point score is used: • test - 2 points, • exercise - 3 points To complete the exercise, you need 3 points. The final grade is the average of grades for all exercises (converted from point grades). All exercises are required. Final mark is the average from both marks (lecture & laboratory)	
Ways of verifying learning outcomes	See **TABLE No 48**	
Exam	No	
D. Student's contribution		
Number of ECTS points	2	
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours - 32, including; a) lecture – 15 h b) laboratory - 15 h; c) consultations – 2 h. 2) Student's individual work - 20 h, including: a) preparation for the test - 5 h; b) ongoing preparation for exercises - 15 h; 3) TOTAL – 52.	
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,28 ECTS points – number of contact hours -32, including: a) lecture – 15 h b) laboratory - 15 h; c) consultations – 2 h	
Number of ECTS points obtained by a student within practical classes:	1,2 ECTS points – number of contact hours -30, including: a) laboratory – 15 h; b) ongoing preparation for exercises - 15 h;	
E. Additional information		
Comments		

TABLE No 48. SUBJECT OUTCOMES
Knowledge

Outcome:	Has the knowledge necessary to build programs for registration and analysis of signals and the construction of control systems, including software working in real-time systems.
Code:	1150-00000-ISA-0398_W1
Verification:	Tests checking preparation for classes and the level of assimilation of previous exercises. Evaluation of the quality of the written software.
Connected field of study outcomes:	K_W15, K_W17
Outcome:	Has basic knowledge about CAN networks used in automotive and machine industry
Code:	1150-00000-ISA-0398_W2
Verification:	Tests checking preparation for classes and the level of assimilation of previous exercises. Evaluation of the quality of the written software.
Connected field of study outcomes:	K_W14
Skills	
Outcome:	Can acquire information from literature, databases and sources, also in English; can integrate the obtained information, make their interpretation and use in the construction of software.
Code:	1150-00000-ISA-0398_U1
Verification:	Tests checking the preparation for classes and the degree of acquiring knowledge from previous exercises. Evaluation of the quality of written software.
Connected field of study outcome:	K_U01, K_U05
Outcome:	Can independently improve the knowledge gained during programming classes
Code:	1150-00000-ISA-0398_U2
Verification:	Tests checking the preparation for classes and the degree of acquiring knowledge from previous exercises. Evaluation of the quality of written software.
Connected field of study outcome:	K_U06
Outcome:	Can create software for recording and analysis of signals for real-time systems, carry out measurements, interpret results obtained and draw conclusions.
Code:	1150-00000-ISA-0398_U3
Verification:	Tests checking the preparation for classes and the degree of acquiring knowledge from previous exercises. Evaluation of the quality of written software.
Connected field of study outcome:	K_U10, K_U12, K_U16, K_U21
Social competences	
Outcome:	Has the ability to work individually and in a team.
Code:	1150-00000-ISA-0398_K1
Verification:	Evaluation of the task performed during the exercise.
Connected field of study outcome:	K_K04, K_K05

Description of a Subject

SUBJECT: FUNDAMENTALS OF MECHATRONIC SYSTEMS DESIGN

Subject code	1150-00000-ISA-0351
Subject version	Version I
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery
Profile of study	General academic

Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Compulsory	
Subject level	Basic	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	5	
Pre-requisites	Mechanics; Automation; Mechatronics	
Limit of number of students	According to the WUT Rector's ordinance	
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	After completing the course, the student should have general theoretical knowledge on: - mathematical models of components of mechatronic systems; - principles of using mathematical models in the construction of mechatronic systems; - design of mechatronic systems using mathematical models of selected elements; After completing the course the student should be able to: - correctly build and apply mathematical models of selected elements of mechatronic systems; - build a computational model of mechatronic systems and perform computer simulations based on it; - analyze the results of computer simulations; - work individually and in a team.	
Learning outcomes	See **TABLE No 49**	
Form of classes and their duration	Lecture	15
	Practicals	
	Laboratory	15
	Project	
Learning content	Lecture: - introduction to mechatronic systems; - harmonic oscillator; - impulse excitation / step enforcement; - representation of the state-space - the criterion of stability Routh - Hurwitz; - sensitivity of the control system. Laboratory - project in Matlab / Simulink - project in Amesim	
Evaluation methods	Written exam from the lecture. Assessment from the laboratory based on class work and reports.	
Ways of verifying learning outcomes	See **TABLE No 49**	
Exam	Yes	
D. Student's contribution		
Number of ECTS points	3	
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours- 32, including: a) lecture - 15 h.; b) laboratory – 15 h c) consultations - 2 h 2) Student's individual work 43 hours, including: a) student's current preparation for laboratories and lectures, literature study – 18 h; b) student's current preparation for exam – 10 h; c) preparation of reports – 15 h. 3) TOTAL – sum of individual work and contact hours 75 h.	
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,28 ECTS points – number of contact hours - 32, including: a) lecture - 15 h.; b) laboratory – 15 h c) consultations - 2 h	
Number of ECTS points obtained by a student	1,2 ECTS points – number of contact hours - 30, including: a) laboratory - 15 h.;	

within practical classes:	n) preparation of reports – 15 h.
E. Additional information	
Comments	

TABLE No 49. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Has knowledge about the process of selecting parameters for controlling physical processes.
Code:	1150-00000-ISA-0351_W1
Verification:	Discussion at the lecture, exam
Connected field of study outcomes:	K_W17
Outcome:	Has knowledge about trends in the development of modern control systems.
Code:	1150-00000-ISA-0351_W2
Verification:	Discussion at the lecture, exam
Connected field of study outcomes:	K_W19
Skills	
Outcome:	He can describe the physical model with motion equations and build a control system based on them.
Code:	1150-00000-ISA-0351_U1
Verification:	Discussion in the laboratory, assessment of the report
Connected field of study outcome:	K_U07, K_U16
Social competences	
Outcome:	He can work individually and in a team.
Code:	1150-00000-ISA-0351_K1
Verification:	Assessment of the tasks performed during the implementation of the exercises and evaluation of the report
Connected field of study outcome:	K_K04

Description of a Subject	
SUBJECT: INTELLIGENT CONSTRUCTION	
Subject code	1150-00000-ISA-0312
Subject version	Version I
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery
Profile of study	General academic
Degree program	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering
Performing unit	Faculty of Automotive and Construction Machinery Engineering
B. General characteristics of the subject	
Subject kind	Connected with the field of study
Subject group	Compulsory
Subject level	Basic
Subject status	Compulsory
Language of instruction	English

Nominal semester	5	
Pre-requisites	Basic knowledge of general mechanics, material strength and vibration theory.	
Limit of number of students	According to the WUT Rector's ordinance	
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Poznanie problemów konstrukcji mechanicznych ze zintegrowanymi elementami pomiarowymi, sterującymi i wykonawczymi. Umiejętność modelowania, analizy i doboru parametrów wybranych układów sterowania drgań i ruchu z zastosowaniem materiałów funkcyjnych. Kreatywność w powiązaniu ze świadomością wymagań i ograniczeń w działaniach inżynierskich	
Learning outcomes	See **TABLE No 50**	
Form of classes and their duration	Lecture	30
	Practicals	
	Laboratory	
	Project	
Learning content	The concept, definitions and examples of intelligent constructions. Layered constructions, piezoelectric application, sensors, executive elements. Frequency characteristics of selected structural elements with piezoelectric elements. Stabilization of beam vibrations, damping of torsional vibrations and flexible shafts. Application of shape memory alloys, influence of thermal activation on system characteristics, vibration stabilization and silencing. The use of electroregological and magnetorheological materials in the construction of machines, as dampers, valves, grippers, bumper elements in construction elements as distributed semi-active silencers. Effect of delamination and cracks on active systems Application of piezoelectric transducers in the system of active vibration reduction of panels and panels, segmentation of executive elements.	
Evaluation methods	The lecture is counted on the basis of a written test	
Ways of verifying learning outcomes	See **TABLE No 50**	
Exam	No	
D. Student's contribution		
Number of ECTS points	2	
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours- 32, including: a) lecture - 30 h.; c) consultations - 2 h 2) Student's individual work 18 hours, including: a) student's current preparation for lectures, literature study – 10 h; b) student's current preparation for test – 8 h; 3) TOTAL – sum of individual work and contact hours 50 h.	
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,28 ECTS points – number of contact hours 32, including: a) lecture - 30 h.; c) consultations - 2 h	
Number of ECTS points obtained by a student within practical classes:		
E. Additional information		
Comments		

TABLE No 50. SUBJECT OUTCOMES
Knowledge

Outcome:	Has basic knowledge of mechanical vibrations, analysis and methods of vibration reduction. Has knowledge of control and dynamic reduction of vibrations and selection of mechanical systems parameters.
Code:	1150-00000-ISA-0312_W1
Verification:	Written test
Connected field of study outcomes:	K_W02, K_W03
Outcome:	He knows the concept of vibration control systems and basic properties of functional materials used.
Code:	1150-00000-ISA-0312_W2
Verification:	Written test
Connected field of study outcomes:	K_W02, K_W03, K_W04
Skills	
Outcome:	Is able to determine the characteristics and select the parameters of the mechanical system based on the criteria used.
Code:	1150-00000-ISA-0312_U1
Verification:	Written test
Connected field of study outcome:	K_U07
Outcome:	Is able to apply mathematical models of simple control systems and active and semi-active vibration reduction and carry out appropriate analyzes, including segmentation of transducers. Is able to carry out basic analysis and select the parameters of the control system, in systems with delamination of semiactive elements and active vibration reduction
Code:	1150-00000-ISA-0312_U1
Verification:	Written test
Connected field of study outcome:	K_U07, K_U16
Social competences	
Outcome:	Creativity in connection with the awareness of requirements and limitations in engineering activities.
Code:	1150-00000-ISA-0312_K1
Verification:	Written test, consultations
Connected field of study outcome:	K_K05

Description of a Subject	
SUBJECT: INTRODUCTION TO ROBOTICS	
Subject code	1150-MT000-ISA-0339
Subject version	Version 1
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery
Profile of study	General academic
Degree program	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering
Performing unit	Faculty of Automotive and Construction Machinery Engineering
B. General characteristics of the subject	
Subject kind	Connected with the field of study

Subject group	Connected with the field of study	
Subject level	Intermediate	
Subject status	Subject of limited choice	
Language of instruction	English	
Nominal semester	5	
Pre-requisites	Basic knowledge in the field of general mechanics, basics of machine construction, multi-component systems and power train systems.	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Learning the role, purpose and operation of robots. Learning to describe robot operation. Developing awareness of purpose and possibilities of robot use.	
Learning outcomes	See **TABLE No 51**	
Form of classes and their duration	Lecture	15 h
	Practicals	-
	Laboratory	
	Project	-
Learning content	1. Basic terms in robotics. 2. Role and classification of robots. 3. Introduction to analysis of robot series kinematics. 4. Analysis of robot kinematics (description of manipulator location in different coordinate systems, establishing operation areas, working, manipulative and border). 5. Introduction to kinematic analysis of parallel robots. 6. Overview of solutions and analysis of kinematic and traction problems of mobile robots. 7. Introduction to dynamic analysis of robot systems. 8. Analysis of dynamics of series and parallel robots. 9. Analysis of dynamics of mobile robots. 10. Elements and structure of power trains: pneumatic, hydraulic, electric (problems with power train transmission, energy problems, dynamics of mobile robots). 11. Structure and construction of power train operation systems: pneumatic, hydraulic, electric. 12. Structure of sensor systems - measurement systems, sensors, feedback sensor systems) 13. Construction of controllers and robot power train regulators. Discussing methods of regulator construction and robot programming. 14. Rules for operation planning and robot programming.	
Evaluation methods	Test, evaluation of homework – conceptual project of a robotics system.	
Ways of verifying learning outcomes	See **TABLE No 51**	
Exam	No	
D. Student's contribution		
Number of ECTS points	1	
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours - 16, *including* a) lecture - 15 h; b) consultations -1 h. 2) Student's individual work – *15* hours, including: a) 5 h – current preparation for the lecture; b) 10h doing homework, conceptual project of a robotic system. 3) TOTAL – 31 h .	

Number of ECTS points for classes requiring direct participation of members of academic staff:	0,64 ECTS point – number of contact hours - 16, including a) lecture - 15 h; b) consultations -1 h.
Number of ECTS points obtained by a student within practical classes:	
E. Additional information	
Comments	

TABLE No 51. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Has knowledge on robot applications and knows how to define the scope of robot movements and robot activities.
Code:	1150-MT000-ISA-0339_W1
Verification:	Test
Connected field of study outcome	K_W17; K_W18; K_W19; K_W20
Outcome:	Has well-ordered and theoretically based knowledge in term of key issues of robot kinematics, properties, construction and optimization of robot operation.
Code:	1150-MT000-ISA-0339_W2
Verification:	Homework – description of an idea for solution of a robotic problem.
Connected field of study outcome	K_W17; K_W18; K_W19; K_W20
Skills	
Outcome:	Can conduct basic calculations of assemblies of kinetic system of a robot and dynamic strains.
Code:	1150-MT000-ISA-0339_U1
Verification:	Test
Connected field of study outcome	K_U15; K_U16; K_U17; K_U18
Outcome:	Can define problems to solve in a robotic problem. Can design movements of robot elements.
Code:	1150-MT000-ISA-0339_U2
Verification:	Homework. Oral presentation of a performed task.
Connected field of study outcome	K_U15; K_U16; K_U17; K_U18
Social Competences	
Outcome:	Can cooperate and work in a group while performing group tasks during classes. Cam discuss and present ideas.
Code:	1150-MT000-ISA-0339_K1
Verification:	Presenting own idea for a solutions of a robotic problem during classes.
Connected field of study outcome	K_K04

Description of a Subject	
SUBJECT: REPAIR OF VEHICLE MECHATRONIC SYSTEMS	
Subject code	1150-MT000-ISA-0340
Subject version	Version 1
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery

Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Connected with the field of study	
Subject level	Intermediate	
Subject status	Subject of limited choice	
Language of instruction	English	
Nominal semester	5	
Pre-requisites	Basic knowledge in construction of vehicle systems, control systems, sensor systems etc.	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Learning the ability to analyze ways of functioning of mechatronics vehicle systems and based on this establishing causes of faults and eliminating them.	
Learning outcomes	See **TABLE No 52**	
Form of classes and their duration	Lecture	15 h
	Practicals	
	Laboratory	
	Project	
Learning content	Rules for verifying and assessing condition of mechatronic system elements: control, air control, exhaust fumes outlet in modern combustion engines. Presenting exhaust gas recirculation systems and mechatronic systems of exhaust gas purification. Methods of evaluating condition of mechatronics vehicle safety systems will be presented. Analysis of dependencies betweem signals from sensors and physical phenomena acting on a vehicle, making decisions od interaction and ways of its proper realization. Influence of malfunctions on environment considering particularly safety and impact on environment, will be discussed.	
Evaluation methods	Test	
Ways of verifying learning outcomes	See **TABLE No 52**	
Exam	No	
D. Student's contribution		
Number of ECTS points	1	
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours – 16, including: a) lecture -15 h; b) consultations - 1 h; 2) Student's individual work – 9 hours, including: a) 4 h –current preparation for classes, literature study, b) 5 h – preparation for test. 3) TOTAL – 25 h.	
Number of ECTS points for classes requiring direct participation of members of academic staff:	0,64 ECTS point – number of contact hours – 16, including: a) lecture -15 h; b) consultations - 1 h;	
Number of ECTS points obtained by a student within practical classes:	-	
E. Additional information		

Comments	

TABLE No 52 . SUBJECT OUTCOMES	
Knowledge	
Outcome:	A student can draw conclusions on processes occurring in a vehicle based of available IT signals.
Code:	1150-MT000-ISA-0340_W1
Verification:	Test
Connected field of study outcome	K_W13
Outcome:	A student cam describe the influence of parameters on vehicle system operation.
Code:	1150-MT000-ISA-0340_W2
Verification:	Test
Connected field of study outcome	K_W13.
Outcome:	A student can characterize tasks of particular systems and their influence on vehicle.
Code:	1150-MT000-ISA-0340_W3
Verification:	Test
Connected field of study outcome	K_W13.
Skills	
Outcome:	A student can perform an analysis of ways of functioning of vehicle mechatronics systems and based on this define the cause of malfunctions and ways if their removal.
Code:	1150-MT000-ISA-0340_U1
Verification:	Test
Connected field of study outcome	K_U15, K_U16
Social competences	
Outcome:	A student can characterize influence of malfunction of particular systems on environment including safety of traffic participants and environment.
Code:	1150-MT000-ISA-0340_K1
Verification:	Test
Connected field of study outcome	K_K02

Description of a Subject	
SUBJECT: PHYSICS III	
Subject code	1150-00000-ISA-0314
Subject version	Version I
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery
Profile of study	General academic
Degree program	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering
Performing unit	Faculty of Automotive and Construction Machinery Engineering
B. General characteristics of the subject	
Subject kind	Connected with the field of study

Subject group	Compulsory	
Subject level	Basic	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	6	
Pre-requisites	Physics I and Physics II	
Limit of number of students	According to the Rector regulations	
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Main aims: 1. Getting students acquainted with description of waves, as well as basics of geometrical and wave optics. 2. Presentation of practical applications of geometrical and wave optics in technical sciences and in vehicles. 2. Presentation of various light sources, particularly those applied in modern vehicles, together with the physical principles of their operation. 3. Critical assessment of the properties of light sources, their characteristics and parameters important from practical point of view. After the lectures, the student should be able to choose the appropriate light source for a given application. 4. Teaching the ability to properly describe, parametrize and compare various light sources, in both qualitative and quantitative way. Getting the students acquainted with basic characterization methods of light sources, photometry and proper use of photometric units.	
Learning outcomes	See **TABLE No 53**	
Form of classes and their duration	Lecture	30
	Practicals	
	Laboratory	
	Project	
Learning content	(1) Wave motion, analogies to harmonic oscillations. Wave equation. Examples of different waves. Acoustic waves, Doppler effect. (2) Electromagnetic waves - Maxwell equations, spectrum of E-M waves. Poyinting vector. Dispersion of E-M waves. (3) Propagation of a lightwave-Fermat principle. Elements of geometrical optics. Phase ang group velocity. (4) Wave optics: interference, Young experiment, interferometry, interference colours and antireflex coatings. Diffraction and diffraction resolution limit, diffraction lenses. Polarization, birefringence. Optical properties of liquid crystals, LCD displays. (5) Photon as a quantum of light. Blackbody radiation. Emission and absorption. Wien displacement law. Spectral temperature. Photoelectric effect, Compton effect. Incadescent bulb and halogen bulb. Standard bulbs for vehicles. (6) Wave properties of matter. Bohr model - calculation of electron energy. Hydrogen spectrum, spectra of other gases and elements. Discharge lamps and their application in HID lights. Luminescence, luminofores. Flame spectrum. X-ray and X-ray lamp. (7) Quantum physics. Wave function, Schrödinger equation - selected solutions. Tunelling effect. Atom as a potential well - description of electrons. Quantum atom model. Wuantum numbers and their interpretation. Electron shells - principles of occupation. Periodic table of elements. (8) Quantum statistics. Lasers - principles of operation and applications in vehicles and transport. (9) Elements of solid state physics - band structure of solids. Principles of semiconductors, doping of semiconductors. P-n junction. Light emitting diodes (LEDs) and their application on vehicles and road lights. Photodiodes. (10) Elements of photometry., Radiometric and photometric quantities. Application of photometry in parametrization of light sources. Comparison of light sources.	
Evaluation methods	Two tests, in 8 and 15 lecture. Additional short tests during lectures. The final grade is calculated directly according to the number of points (24 max). 50% required to pass the subject. . Grades: 0-12 2.0 12.1-14.5 3.0 15.6-16.9 3.5 17-19.3 4.0 19.4-21.7 4.5 21.8-24 5.0	

Ways of verifying learning outcomes	See **TABLE No 53**
Exam	No
D. Student's contribution	
Number of ECTS points	2
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours- 31, including: a) lecture - 30 h.; b) consultations - 1 h 2) Student's individual work 25 hours, including: a) student's current preparation for lectures, literature study – 15 h; b) student's current preparation for test – 10 h; 3) TOTAL – sum of individual work and contact hours 56 h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,24 ECTS points – number of contact hours 31, including: a) lecture - 30 h.; c) consultations -1 h
Number of ECTS points obtained by a student within practical classes:	
E. Additional information	
Comments	

TABLE No 53. SUBJECT OUTCOMES	
Knowledge	
Outcome:	The student knows different kinds of waves and their properties. Has systematic knowledge regarding the matematical apparatus used for description of wave motion and wave functions. Student is capable of qualitative explanation of intereference and diffraction effects using properties of wave functions.
Code:	1150-00000-ISA-0314_W1
Verification:	Test (after 1st half of the semester)
Connected field of study outcomes:	K_W02, K_W01
Outcome:	He knows the practical applications of individual light sources. He can describe the construction of their sources and explain the principle of their operation.
Code:	1150-00000-ISA-0314_W2
Verification:	Test (after 2nd half of the semester)
Connected field of study outcomes:	K_W02, K_W03
Skills	
Outcome:	Can calculate and estimate basic parameters describing waves and their propagation in space. He can apply the wave equation to calculate the wave intensity at a given point in space.
Code:	1150-00000-ISA-0314_U1
Verification:	Quality control of self-written software
Connected field of study outcome:	K_U01
Outcome:	Manages to choose the right light source for a given application, and is able to justify this choice by presenting advantages and disadvantages of each light source. Manages to select proper supply for the light source.
Code:	1150-00000-ISA-0314_U2
Verification:	Quality control of performing laboratory exercises
Connected field	K_U07

of study outcome:	
Social competences	
Outcome:	Understands the role of appropriate selection of light sources in assertion of comfort and safety in both work and common life. Is able to estimate the economic aspects of application of various light sources, as well as indicate light sources which create less impact on natural environment.
Code:	1150-00000-ISA-0314_K1
Verification:	Quality control of performing laboratory exercises
Connected field of study outcome:	K_K02

Description of a Subject		
SUBJECT: INTRODUCTION TO DIAGNOSTICS		
Subject code	1150-00000-ISA-0318	
Subject version	Version I	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	General academic	
Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Compulsory	
Subject level	Basic	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	6	
Pre-requisites	Required knowledge of mathematical analysis, the fundamentals of physics in particular the theory of vibration, mechanics and strength of materials.	
Limit of number of students	According to the Rector regulations	
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Acquisition of knowledge in the field of mathematics, physics, chemistry and other areas appropriate for the studied direction, useful for formulating and solving simple tasks in the field of diagnostics, maintenance of technical objects. Understanding the construction and operation of diagnostic systems. Understanding the economic, social, legal and operational aspects of diagnostics and trends in the development of modern mechanical systems. Acquire the skills of analysis and identification of the way of acting, evaluation and formulation of simple engineering tasks. Understanding the seriousness of the ecological, economic, environmental, effects of worn out machines and equipment and the need to diagnose such equipment.	
Learning outcomes	See **TABLE No 54**	
Form of classes and their duration	Lecture	15
	Practicals	
	Laboratory	15
	Project	
Learning content	Lecture: General knowledge on the principles of technical problem solving,	

	methods and means of diagnosis. 1. Models of faults and processes. 2. Physical signal models. 3. Fault detection based on signal model. 4. Analysis of periodic signals. 5. Detection of errors and defects by means of process identification. 6. Comparison of fault detection methods. 7. Diagnostic procedures. 8. Diagnosis of damage by classification methods. 9. Diagnostic inference 10. Statistical methods in diagnostics. 11. Diagnostic experiments. Lab: Practical familiarization with methods and means of technical diagnostics. 1. The use of wave phenomena in the diagnosis of compressed structures. 2. Diagnosis of stress state. 3. Diagnosis of the gigacycle fatigue process. 4. Diagnostics of hydraulic actuators of hydraulic systems. 5. Diagnostics of construction using modal analysis.
Evaluation methods	Laboratory: Each laboratory exercise is evaluated immediately after its completion. The basis for the assessment is the correct execution of the exercise completed by the report and its oral defense. This is possible after the student has been admitted to perform the exercise after a prior verification of the student's preparation for the course. The requirement for a laboratory to be completed is to complete all the exercises provided in the program in a given semester and to pass each class on at least 3. The final grade of the laboratory is determined on the basis of the average number of grades obtained from each laboratory activity. Average corresponds, after rounding, the final evaluation. Lecture: The lecture veryfication takes place during the written examination, according to the schedule of the examination session. Overall rating: The total grade is the weighted average of the grades obtained from the laboratory and lecture sections. The condition of receiving a positive assessment is to pass a minimum grade of 3.0 in both the laboratory and the lecture.
Ways of verifying learning outcomes	See **TABLE No 54**
Exam	Yes
D. Student's contribution	
Number of ECTS points	2
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours - 32 h, including:, a) lecture - 15 h; b) laboratory- 15 h.; c) consultations - 2 h; 2) Student's individual work – 20 h, including: a) literature study: 5 h; b) preparation for classes: 5 h; c) preparation for exam: 5 h; d) preparing reports: 5 h. 3) TOTAL – 52 h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,28 ECTS points – number of contact hours - 32 h, including:, a) lecture - 15 h; b) laboratory- 15 h.; c) consultations - 2 h;
Number of ECTS points obtained by a student within practical classes:	0,8 ECTS point - 20 h of student's individual work, including: a) participating in laboratory exercises - 15 h; b) preparing laboratory report - 5 h.
E. Additional information	
Comments	

TABLE No 54. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Has an systematized, theoretical background in the field of technical diagnostics

	problems.
Code:	1150-00000-ISA-0318_W1
Verification:	Discussion during the lecture, exam
Connected field of study outcomes:	K_W05, K_W14
Outcome:	Possesses the general knowledge needed to understand the economic, social and legal aspects of technical diagnostics.
Code:	1150-00000-ISA-0318_W2
Verification:	Discussion during the lecture, exam
Connected field of study outcomes:	K_W21
Outcome:	Possesses basic knowledge about development trends in the field of technical diagnostics.
Code:	1150-00000-ISA-0318_W3
Verification:	Discussion during the lecture, exam
Connected field of study outcomes:	K_W16
Outcome:	Possesses basic knowledge of the life cycle of technical objects and understands the seriousness of the ecological aspects of technical diagnostics.
Code:	1150-00000-ISA-0318_W4
Verification:	Discussion during the lecture, exam
Connected field of study outcomes:	K_W15
Skills	
Outcome:	Has an knowledge to plan and perform diagnostic tests using appropriate methods and means.
Code:	1150-00000-ISA-0318_U1
Verification:	Short oral / written test verifying student's preparation for laboratory exercises, evaluation of the report.
Connected field of study outcome:	K_U12, K_U13, K_U20
Outcome:	Possesses the ability to set priorities appropriately for the fulfilment of other tasks.
Code:	1150-00000-ISA-0318_U2
Verification:	Evaluation of results in laboratory exercises and assessment of the report.
Connected field of study outcome:	K_U02
Social competences	
Outcome:	Posseses abilty to work independently and in a team.
Code:	1150-00000-ISA-0318_K1
Verification:	Assessment of tasks performed during laboratory exercises and evaluation of the report.
Connected field of study outcome:	K_K04

Description of a Subject	
SUBJECT: HYDRAULIC AND PNEUMATIC SYSTEMS	
Subject code	1150-MT000-ISA-0316
Subject version	Version 1
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery

Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Connected with the field of study	
Subject level	Intermediate	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	6	
Pre-requisites	Basic knowledge of basic terms related to hydraulic, pneumatic, electric power train and control, basic knowledge in construction, operation of hydraulic and pneumatic elements (participation in lectures: Basics for Hydraulic and Pneumatic Power Trains, Construction Machinery)	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Within the subject, students will learn basic terms connected with power train, control, and design of hydraulic and pneumatic elements and rules connected with selection of components and their operation. During the lecture students will gain experience in intuitive methods on hydraulic and pneumatic system design. They will gain a skill of selecting kind and basic parameters of power train system, working (hydrostatic or pneumatic) and its systems for a particular vehicle, machine or device. Ability to draw and read schemes of pneumatic and hydraulic systems. Students will gain knowledge on criteria of executive element control in pneumatic and hydraulic systems. They can control executive elements of designed hydraulic or pneumatic power train. They have knowledge on elements applied in hydraulic and pneumatic systems.	
Learning outcomes	See **TABLE No 55**	
Form of classes and their duration	Lecture	30 h
	Practicals	-
	Laboratory	-
	Project	-
Learning content	1. Basic issues in design of hydraulic and pneumatic systems. The issues are connected with: ways and sequence actions while designing and calculating hydraulic and pneumatic power trains. 2. Power trains (hydrokinetic, hydrostatic, hydrostatic-mechanical) and control of vehicles and construction machinery. 3. Rules for choosing hydraulic elements of system design. Presenting sample schemes of power train hydraulic systems and equipment in construction machinery. Discussing rules for starting hydraulic systems. 4. Discussing simple hydraulic and pneumatic control systems. Fluid circulations (open, half-closed, closed). 5. Basic safeguards for hydrostatic systems against overload and enabling proper operation and varying pressure in different circuits of the system. 6. Rules for cooperation of a few hydraulic pumps. 7. Synchronization of pneumatic actuator, piston and hydraulic engine movements. 8. General rules for control and regulation: mechanical, electromechanical, volume hydraulic, throttle hydraulic, servo hydraulic, proportional electric, electric servo. 9. Discussing control elements in hydraulic systems and systems of their connections in hydraulic power trains. 10. Discussing control elements in pneumatic systems and systems of their connections in pneumatic power trains.	

Evaluation methods	Credit granted on the basis of two written test (with a minimal pass grade of 3.0). Final grade is arithmetical average of pass marks obtained from two tests.
Ways of verifying learning outcomes	See **TABLE No 55**
Exam	No
D. Student's contribution	
Number of ECTS points	2
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours - 31, including: a) lecture - 30 h; b) consultations - 1 h. *2*) Student's individual work -19, including: a) 5 h – current preparation for lecture, b) 5 h –literature study, c) 9 h – preparing for tests, 3) TOTAL –50 h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,24 ECTS point – number of contact hours - 31, including: a) lecture - 30 h; b) consultations - 1 h.
Number of ECTS points obtained by a student within practical classes:	
E. Additional information	
Comments	

TABLE No 55. SUBJECT OUTCOMES	
Knowledge	
Outcome:	A student has knowledge on elements applied in hydraulic and pneumatic systems.
Code:	1150-MT000-ISA-0316_W1
Verification:	Test
Connected field of study outcome	K_W11, K_W12, K_W17
Outcome:	A student has detailed knowledge connected with construction and functioning of hydraulic and pneumatic systems and devices.
Code:	1150-MT000-ISA-0316_W2
Verification:	Test
Connected field of study outcome	K_W11, K_W12, K_W17
Outcome:	Has knowledge on elements applied in hydraulic and pneumatic systems.
Code:	1150-MT000-ISA-0316_W3
Verification:	Test
Connected field of study outcome	K_W11, K_W12, K_W17
Outcome:	Knows control systems in machines and devices with hydraulic and pneumatic power train.
Code:	1150-MT000-ISA-0316_W4
Verification:	Test
Connected field of study outcome	K_W04
Outcome:	Knows criteria for designing hydraulic and pneumatic systems.
Code:	1150-MT000-ISA-0316_W5

Verification:	Test
Connected field of study outcome	K_W11, K_W12, K_W17
Outcome:	Knows rules for selection of elements of designed system.
Code:	1150-MT000-ISA-0316_W6
Verification:	Test
Connected field of study outcome	K_W11, K_W12, K_W17
Outcome:	Can control executive elements of designed hydraulic or pneumatic power train.
Code:	1150-MT000-ISA-0316_W7
Verification:	Test
Connected field of study outcome	K_W13
Skills	
Outcome:	A student can plan and build hydraulic and pneumatic systems.
Code:	1150-MT000-ISA-0316_U1
Verification:	Test
Connected field of study outcome	K_U01, K_U04, K_U07, K1_U08, K_U14, K_U18
Outcome:	A student can use simulation methods to design and evaluate hydraulic and pneumatic systems and control systems.
Code:	1150-MT000-ISA-0316_U2
Verification:	Test
Connected field of study outcome	K_U09
Outcome:	A student can perform analysis of functioning of existing hydraulic and pneumatic systems and present methods of improving system functionality.
Code:	1150-MT000-ISA-0316_U3
Verification:	Test.
Connected field of study outcome	K_U15
Outcome:	Knows rules for selection of elements for designed system.
Code:	1150-MT000-ISA-0316_U4
Verification:	Test.
Connected field of study outcome	K_U03
Outcome:	Can read schemes of hydraulic and pneumatic systems.
Code:	1150-MT000-ISA-0316_U5
Verification:	Test.
Connected field of study outcome	K_U03

Description of a Subject

SUBJECT: IMAGE PROCESSING AND ANALYSIS

Subject code	1150-00000-ISA-0306
Subject version	Version I
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery
Profile of study	General academic
Degree program	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering

Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Compulsory	
Subject level	Basic	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	6	
Pre-requisites	Basic knowledge of image processing. Computer skills, basic knowledge in programming in the Matlab and LabView environment.	
Limit of number of students	No limit on the student number at the lecture. The maximum number of students taking part in laboratory classes is 30 people.	
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Getting to know the theory of car traffic and general knowledge about their construction. The ability to apply the laws of physics to the description of car traffic. Awareness of requirements and limitations in engineering activities.	
Learning outcomes	See **TABLE No 56**	
Form of classes and their duration	Lecture	15
	Practicals	
	Laboratory	30
	Project	
Learning content	Lecture: Contextual filtering of images. Linear and non-linear context filters. Basic and complex morphological transformations of images. Morphological transformations of binary images. Fourier transformation of digital images. Hough's transformation of digital images. Image segmentation. Image labeling. Determining global image features. Determining the characteristics of the figures (objects) of the image. Laboratory: Introduction to Matlab's Image Processing Toolbox. Data structures used to represent images and methods of their conversion. Discrete structure of digital images. Geometric, arithmetic and logical transformations of images. Point image transformations. Contextual filtering of the image. Fourier transformation of digital images. Morphological transformations of the image. Detection of contour lines using the Hough transform. Introduction to Matlab's Image Acquisition Toolbox. Acquisition of images in the LabVIEW environment. Image segmentation. Determining the characteristics of the figures (objects) of the image. Image analysis in the LabVIEW environment.	
Evaluation methods	Lecture: Completion of the lecture part of the subject takes place on the basis of a written colloquium. A necessary condition for completing the lecture part of the subject is to obtain at least a sufficient grade from the colloquium. Laboratory: A necessary condition for completing the laboratory part of the subject is the performance in the given semester of all the laboratory exercises provided for in the program and passing each exercise to at least a satisfactory grade. Each exercise is counted by the person conducting the exercise based on checking the correctness of this laboratory exercise. The necessary condition for completing the course is to pass the lecture and laboratory parts of the subject. The total mark from the subject is the weighted average of the grades from the lecture and laboratory parts of the subject.	
Ways of verifying learning outcomes	See **TABLE No 56**	
Exam	No	
D. Student's contribution		
Number of ECTS points	3	
Number of hours of	1) Number of contact hours- 47, including:	

student's work connected with achieving learning outcomes:	a) lecture - 15 h.; b) laboratory – 30 h; c) consultations - 2 h 2) Student's individual work 44 hours, including: a) student's current preparation for lectures, literature study – 5 h; b) student's current preparation for test – 4 h; c) ongoing preparation for laboratory exercises -20 h; d)) preparing reports for laboratory – 15 h 3) TOTAL – sum of individual work and contact hours 91 h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,88 ECTS points – number of contact hours 47, including: a) lecture - 15 h.; b) laboratory – 30 h; c) consultations - 2 h
Number of ECTS points obtained by a student within practical classes:	2 ECTS points – number of contact hours -50, including: a) laboratory – 15 h; b) ongoing preparation for exercises -20 h; c) preparing reports for laboratory – 15 h
E. Additional information	
Comments	

TABLE No 56. SUBJECT OUTCOMES	
Knowledge	
Outcome:	A student who has passed the course possesses detailed knowledge of image processing and analysis methods.
Code:	1150-00000-ISA-0306_W1
Verification:	Written test.
Connected field of study outcomes:	K_W07
Skills	
Outcome:	A student who has passed the course can gain information from context-sensitive help systems in the development environment (in English); A student can integrate obtained information, interpret it and use it in software development.
Code:	1150-00000-ISA-0306_U1
Verification:	Quality control of self-written software
Connected field of study outcome:	K_U01, K_U24
Outcome:	A student who has passed the course can build basic programs for image acquisition in Matlab and LabVIEW environments.
Code:	1150-00000-ISA-0306_U2
Verification:	Quality control of performing laboratory exercises
Connected field of study outcome:	K_U08
Outcome:	A student who has passed the course can build programs for image processing and analysis in Matlab and LabVIEW environments.
Code:	1150-00000-ISA-0306_U3
Verification:	Quality control of performing laboratory exercises
Connected field of study outcome:	K_U18
Social competences	
Outcome:	A student who has passed the course can properly determine the priorities for the performance of the task determined by other people.
Code:	1150-00000-ISA-0306_K1

Verification:	Quality control of performing laboratory exercises
Connected field of study outcome:	K_K04

Description of a Subject		
SUBJECT: MECHATRONICS SYSTEMS DESIGN		
Subject code	1150-00000-ISA-0337	
Subject version	Version I	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	General academic	
Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Compulsory	
Subject level	Basic	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	6	
Pre-requisites	Knowledge of Matlab / Simulink and Amesim software. Fundamentals of Mechatronic Systems Design.	
Limit of number of students	According to the Rector regulations	
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	After completing the course, the student should have general theoretical knowledge on: - mathematical models of components of mechatronic systems; - principles of using mathematical models in the construction of mechatronic systems; - design of mechatronic systems using mathematical models of selected elements; After completing the course the student should be able to: - correctly build and apply mathematical models of selected elements of mechatronic systems; - build a computational model of mechatronic systems and perform computer simulations based on it; - analyze the results of computer simulations; - work individually and in a team.	
Learning outcomes	See **TABLE No 57**	
Form of classes and their duration	Lecture	
	Practicals	
	Laboratory	
	Project	30
Learning content	Project: During the project classes, students use the knowledge gained during the lecture: Fundamentals of Mechatronics Systems Design. The aim of the project is to define a mathematical model and parameters for performing appropriate simulations of mechatronic systems in Matlab / Simulink and Amesim software.	
Evaluation methods	Current assessment of progress in projects and reports.	
Ways of verifying learning outcomes	See **TABLE No 57**	
Exam	No	
D. Student's contribution		
Number of ECTS points	2	

Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours- 32, including: a) project - 30 h.; b) consultations - 2 h 2) Student's individual work 18 hours, including: a) current preparation of the student for classes – 5 h; b) literature studies - 5 h; c) preparing reports - 8 h. 3) TOTAL – sum of individual work and contact hours 50 h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,28 ECTS points – number of contact hours - 32, including: a) project - 30 h.; b) consultations - 2 h;
Number of ECTS points obtained by a student within practical classes:	1,6 ECTS points – number of contact hours - 40, including: a) project – 30 h; b) current preparation of the student for classes – 5 h; c) preparing projects - 5 h.
E. Additional information	
Comments	

TABLE No 57. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Student is able to define the requirements for basic mechatronic systems.
Code:	1150-00000-ISA-0337_W1
Verification:	Project evaluation.
Connected field of study outcomes:	K_W18, K_W20,K_W17
Outcome:	Student is able to choose modelling methods.
Code:	1150-00000-ISA-0337_W2
Verification:	Project evaluation.
Connected field of study outcomes:	K_W18, K_W09
Skills	
Outcome:	The student is able to use information and communication techniques appropriate to the implementation of tasks typical of engineering.
Code:	1150-00000-ISA-0337_U1
Verification:	Project evaluation.
Connected field of study outcome:	K_U10
Outcome:	The student is able to determine the priorities for the implementation of a task set by himself or others.
Code:	1150-00000-ISA-0337_U2
Verification:	Project evaluation.
Connected field of study outcome:	K_U02
Social competences	
Outcome:	The student is able to work individually and in a team.
Code:	1150-00000-ISA-0337_K1
Verification:	Evaluation of the project implementation.
Connected field of study outcome:	K_K04

Description of a Subject

SUBJECT: FUNCTIONAL MODELS OF CONSTRUCTION MACHINERY AND EQUIPMENT		
Subject code	1150-MT000-ISA-0338	
Subject version	Version 1	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Institute of Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Connected with the field of study	
Subject level	Intermediate	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	6	
Pre-requisites	Basic knowledge in automation of construction machinery	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Learning purpose and ruled for modelling of construction machinery. Gaining basic skills of defining the purpose of building functional models of construction machinery and equipment.	
Learning outcomes	See **TABLE No 58**	
Form of classes and their duration	Lecture	15 h
	Practicals	15 h
	Laboratory	
	Project	-
Learning content	**Lecture**. Aims and ruled for modelling. Rules for preparing functional models. Methodology of functional analysis (MR). Methodology of building functional models. Examples of building functional model of machines and typical kinematic and dynamic systems of digger, loader, bulldozer, crusher, gantry crane, passenger lift, tower and telescopic crane, forklift, tractor. Construction of environment influencing functional models.. Establishing algorithms of on-board computer system operation in terms of power transmission control and equipment control. Choice of machine for a task. **Practicals.** Preparing functional models of machines and typical kinematic and dynamic systems of digger, loader, bulldozer, crusher, gantry crane, passenger lift, tower and telescopic crane, forklift, tractor. Construction of environment influencing functional models. Preparing algorithms of operation. Choice of a machine for a task.	
Evaluation methods	**Lecture**: credit granted based on a test. **Practicals:** It is compulsory to prepare for classes which is verified during classes while preparing functional models, algorithms of machine operation and selecting machined for a task given by the Subject Supervisor. Team work while building functional models during classes. Test during the last class and active participation in classes.	
Ways of verifying learning outcomes	See **TABLE No 58**	
Exam	No	

D. Student's contribution	
Number of ECTS points	2
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours – 32 h, including: a) lecture – 15 h; b) laboratory – 15 h; c) consultations – 2 h; 2) Student's individual work - 28 h , including: a) 10 h – preparing for practicals; e) 18 h – performing assigned tasks. 3) TOTAL –*60* h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,28 ECTS point – number of contact hours - 32, including: a) lecture – 15 h; b) laboratory – 15 h; c) consultations – 2 h;
Number of ECTS points obtained by a student within practical classes:	1,8 ECTS points – 45 h, including: 1) practicals – 15 h; 2) 10 h – preparing for practicals; 3) 18 h – preparing tasks and reports.
E. Additional information	
Comments	

TABLE No 58. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Has knowledge on construction and functioning of construction machinery and its elements and subassemblies.
Code:	1150-MT000-ISA-0338_W1
Verification:	Lecture – test. Practicals – evaluation of performed tasks while doing exercises, student's active participation in classes, test.
Connected field of study outcome e	K_W19,K_W17,K_W16
Outcome:	Has knowledge on construction of functional model: elements, subassemblies and MR systems.
Code:	1150-MT000-ISA-0338_W2
Verification:	Lecture – test. Practicals – evaluation of performed tasks while doing exercises, student's active participation in classes, test.
Connected field of study outcome	K_W20.
Outcome:	Has knowledge in modelling of mechatronic and power train systems of construction machinery.
Code:	1150-MT000-ISA-0338_W3
Verification:	Lecture – test. Practicals – evaluation of performed tasks while doing exercises, student's active participation in classes, test.
Connected field of study outcome	K_W19,K_W12,K_W18
Outcome:	Knows ruled for building functional models.
Code:	1150-MT000-ISA-0338_W4
Verification:	Lecture – test. Practicals – evaluation of performed tasks while doing exercises, student's active participation in classes, test.
Connected field of study outcome	K_W19,K_W12,K_W18,K_W21.
Skills	
Outcome:	Can choose a machine for a task and prepare algorithm of its operation.
Code:	1150-MT000-ISA-0338_U1

Verification:	Test and homework.
Connected field of study outcome	K_U10,K_U18
Outcome:	Can build a functional model: of elements, subassemblies and systems of construction machinery.
Code:	1150-MT000-ISA-0338_U2
Verification:	Lecture – test. Practicals – evaluation of performed tasks while doing exercises, student's active participation in classes, test.
Connected field of study outcome	K_U10,K_U15
Outcome:	Models mechatronic and power train systems of construction machinery.
Code:	1150-MT000-ISA-0338_U3
Verification:	Practicals – evaluation of performed tasks while doing exercises, student's active participation in classes, test.
Connected field of study outcome	K_U16,K_U17
Social Competences	
Outcome:	Can cooperate and work in a group while performing tasks.
Code:	1150-MT000-ISA-0338_K1
Verification:	Evaluation of performed tasks while doing exercises.
Connected field of study outcome	K_K04

Description of a Subject	
SUBJECT: DIAGNOSTICS OF MECHATRONIC SYSTEMS	
Subject code	1150-MT000-ISA-0353
Subject version	Version 1
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time
Field of study	Mechatronics of Vehicles and Construction Machinery
Profile of study	General academic
Degree program	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering
Performing unit	Faculty of Automotive and Construction Machinery Engineering
B. General characteristics of the subject	
Subject kind	Connected with the field of study
Subject group	Connected with the field of study
Subject level	Intermediate
Subject status	Limited choice
Language of instruction	English
Nominal semester	VI
Pre-requisites	Knowing construction and operation of vehicle mechatronic systems.
Limit of number of students	According to University Regulations
C. Learning outcomes and the manner of conducting classes	
Aim of the subject	The aim of the subject is to develop knowledge and skills in terms of methods used in mechatronic system diagnostics.
Learning outcomes	See **TABLE No 59**
Form of classes and their duration	Lecture
	Practicals

	Laboratory	15
	Project	
Learning content	As part of the laboratory there will be practical classes covering: Complex diagnostic model of multi-domain system. Diagnostic interface of construction machinery operator. Data acquisition in complex mechatronic systems. Energy Cogeneration System. Diagnostic system of a vehicle.	
Evaluation methods	Evaluation of student's involvement in performing laboratory tasks, evaluation of report, conversation while accepting a report. In order to obtain credit it is compulsory to pass all exercises.	
Ways of verifying learning outcomes	See **TABLE No 59**	
Exam	No	
D. Student's contribution		
Number of ECTS points	1	
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours - 20, a) laboratory- 15 h; b) consultations - 1 h; 2) Student's individual work - 9 h preparing reports 3) TOTAL - 25.	
Number of ECTS points for classes requiring direct participation of members of academic staff:	0,64 ECTS point – number of contact hours - 16, a) laboratory- 15 h; b) consultations - 1 h;	
Number of ECTS points obtained by a student within practical classes:	1 ECTS point – 25 hours, including: a) laboratory - 15 h; b) consultations - 1 h; c) preparing reports - 9 h.	
E. Additional information		
Comments		

TABLE No 59 . SUBJECT OUTCOMES	
Knowledge	
Outcome:	A student can effectively use diagnostic tools.
Code:	1150-MT000-ISA-0353_W1
Verification:	Knowledge is verified while performing tasks and during conversation while accepting a report.
Connected field of study outcome	K_W17
Outcome:	Based on acquired measurements, a student can verify the accuracy of system operation.
Code:	1150-MT000-ISA-0353_W1
Verification:	Knowledge is verified while performing tasks and during conversation while accepting a report.
Connected field of study outcome	K_W17, K_W18
Skills	
Outcome:	A student can perform measurements using diagnostic tools
Code:	1150-MT000-ISA-0353_U1
Verification:	Knowledge is verified while performing tasks and during conversation while accepting a report.

Connected field of study outcome	K_U13, K_U14, K_U15, K_U16, K_U17, K_U18
Outcome:	A student can determine causes of malfunctions of mechatronic systems.
Code:	1150-MT000-ISA-0353_U1
Verification:	Knowledge is verified while performing tasks and during conversation while accepting a report.
Connected field of study outcome	K_U13, K_U14, K_U20, K_U24

Description of a Subject		
SUBJECT: DIAGNOSTIC MODELLING OF MECHATRONIC SYSTEMS		
Subject code	1150-MT000-ISA-0342	
Subject version		
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Connected with the field of study	
Subject level	Intermediate	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	6	
Pre-requisites	Basic knowledge of MATLAB/SIMULINK, basics of mechanics	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Learning about construction of dynamic object models. Learning to simulate and study the influence of parameter change (due to malfunction) on the operation of analyzed object. Learning about telediagnostics of systems.	
Learning outcomes	See **TABLE No 60**	
Form of classes and their duration	Lecture	0
	Practicals	0
	Laboratory	15
	Project	0
Learning content	**Laboratory** Learning to perform simulations of dynamic objects. As part of laboratory there will be practical classes covering: Modelling mechatronic systems (MOBIUS), Telediagnostics of systems, Complex diagnostic model of multi-domain system, Model of electric machine, Model of energy storage.	
Evaluation methods	**Laboratory:** Before staring an exercise students' preparation is checked (so called 'entry quiz'). Pass for each exercise is obtained based of properly prepared report in the paper or electronic form, accepted and evaluated by person evaluating given exercise. In order to obtain credit for the course it is obligatory to obtain pass from all exercises.	

Ways of verifying learning outcomes	See **TABLE No 60**
Exam	No
D. Student's contribution	
Number of ECTS points	*1*
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours - 16 including: a) laboratory -15 h; b) consultations - 1 h; 2. Student's individual work – 9 hours, including: a) 9 h – preparing for classes, preparing reports. 3) TOTAL – 27 h
Number of ECTS points for classes requiring direct participation of members of academic staff:	0,64 ECTS point - number of contact hours - 16 including: a) laboratory -15 h; b) consultations - 1 h;
Number of ECTS points obtained by a student within practical classes:	1 ECTS point – 25h including: a) laboratory-15 h; b) consultations- 1 h; c) 9 h – preparing for classes, preparing reports.
E. Additional information	
Comments	

TABLE No 60. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Knows how to build models of dynamic objects.
Code:	1150-MT000-ISA-0342_W1
Verification:	Oral or written verification by answering questions and evaluation of reports.
Connected field of study outcome	K_W07, K_W15, K_W18
Skills	
Outcome:	Can perform analysis and identification of way of functioning of mechatronic system, evaluate and formulate conclusions in simple engineering tasks.
Code:	1150-MT000-ISA-0342_U1
Verification:	Evaluation of reports
Connected field of study outcome e	K_U03, K_U07, K_U10

Description of a subject

SUBJECT: INTRODUCTION TO FINITE ELEMENT METHOD

Subject code	1150-MT000-ISA-0343
Subject version	Version 1
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery
Profile of study	General academic
Degree program	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering
Performing unit	Faculty of Automotive and Construction Machinery Engineering
B. General characteristics of the subject	
Subject kind	Connected with the field of study

Subject group	Connected with the field of study	
Subject level	Intermediate	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	6	
Pre-requisites	Lecture: knowing mechanics and strength of materials, rules for design and modelling of constructions. Laboratory: general knowledge of computer systems aiding engineering design	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Learning basics of Finite Element Method and its use in engineering calculations. Learning to perform calculations using MES software and analysis of obtained results.	
Learning outcomes	See **TABLE No 61**	
Form of classes and their duration	Lecture	15 h
	Practicals	-
	Laboratory	15 h
	Project	-
Learning content	**Lecture:** Basic assumptions of Finite Element Method and main calculation stages. MES in issues of statics: bar-type structure modelling. Frame construction modelling: beam element. Introducing dynamics issues to solving dynamics problems: establishing vibrations and solving equations of motion. Analysis of two- and three-dimensional structures. Kinds of finite elements, rules for creating models and numerical aspects. Introduction to modelling of thermal issues (issue of conductivity and heat flow). Doing calculations by means of a professional MES software. **Laboratory:** Examples of calculations performed using MES software Ansys Workbench (model construction, solution, options of reviewing results, cooperation with other CAD systems): • Static calculations of beams and simple frame constructions (analysis of calculation precision). • Establishing state of strain in flat and three-dimensional constructions (analysis of concentration of strains and influence of model parameters on solution precision). • Analysis of vibrations of simple frame and solid constructions, analysis of bar stability. • Optional: conductivity and heat flow modelling	
Evaluation methods	Lecture: based on synopsis of individual homework. Laboratory: based on reports on MES results obtained for different examples.	
Ways of verifying learning outcomes	See **TABLE No 61**	
Exam	No	
D. Student's contribution		
Number of ECTS points	**2**	
Number of hours of	1) Number of contact hours - 32 h, including:	

student's work connected with achieving learning outcomes:	a) lecture - 15 h; b) laboratory- 15 h; c) consultations - 2 h; *2*) Student's individual work - 18 h, including: a) 2 h. – current preparation for lectures; b) 8 h – doing calculations and preparing reports; c) 8 h – doing homeworks. 3) TOTAL –50 h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,28 ECTS points – number of contact hours - 32 h, including: a) lecture - 15 h; b) laboratory- 15 h; c) consultations - 2 h;
Number of ECTS points obtained by a student within practical classes:	0,8 ECTS points - 20 h of student's individual work, including: a) 2 h – current preparation for lectures; b) 8 h – doing calculations and preparing reports; c) 8 h – doing homework.
E. Additional information	
Comments	

TABLE No 61. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Knows basics of Finite Element Method and knows how it is used to solve engineering problems.
Code:	1150-MT000-ISA-0343_W1
Verification:	Preparing reports on calculation examples.
Connected field of study outcome	K_W18
Outcome:	Knows how to create MES calculation models and knows what factors influence precision of results.
Code:	1150-MT000-ISA-0343_W2
Verification:	Doing calculation examples and homework.
Connected field of study outcome	K_W18
Outcome:	Knows rules for creating a finite element, understands transition from a formulated mathematical solved problem to MES equations, knows MES calculation stages.
Code:	1150-MT000-ISA-0343_W3
Verification:	Doing calculation examples and homework.
Connected field of study outcome	K_W18
Skills	
Outcome:	Can do basic MES calculations using Ansys Workbench software, can interpret obtained results and draw conclusions.
Code:	1150-MT000-ISA-0343_U1
Verification:	Preparing reports on calculation examples.
Connected field of study outcome	K_U16
Outcome:	Can create a correct MES calculation model for various kinds of analyses aiding engineering design.
Code:	1150-MT000-ISA-0343_U2
Verification:	Preparing reports on calculation examples.
Connected field of study outcome	K_U16

Outcome:	Can perform critical analysis of obtained calculation results, is prepared to perform MES calculations for more complex construction systems.
Code:	1150-MT000-ISA-0343_U3
Verification:	Preparing reports on calculation examples.
Connected field of study outcome	K_U18
Social competences	
Outcome:	Is aware of importance of precise calculations of engineering constructions, their influence on safety of a designed object and the need to verify the result.
Code:	1150-MT000-ISA-0343_K1
Verification:	Discussion while doing example calculations and student's comments.
Connected field of study outcome	K_K02

Description of a Subject		
SUBJECT: INTERIM THESIS		
Subject code	1150-MT000-ISA-0328	
Subject version	1	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program	-	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with degree program	
Subject group	Connected with degree program	
Subject level	Advanced	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	6	
Pre-requisites		
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	The aim of the subject is student's completion of the interim thesis.	
Learning outcomes	See **TABLE No 62**	
Form of classes and their duration	Lecture	
	Practicals	
	Laboratory	
	Project	75
Learning content	The subject includes student's own work in the scope necessary to complete the interim thesis, in agreement with the Thesis Supervisor. Topic of the thesis ought to be connected with student's field of study. It should refer to general-engineering issues and should enable the use of technical knowledge gained by a student up to this moment.	
Evaluation methods	Evaluation of the completed interim thesis.	
Ways of verifying learning outcomes	See **TABLE No 62**	
Exam	No	
D. Student's contribution		

Number of ECTS points	4
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours - 75 hours of a project. 2) Student's own work – 35 hours, including: a) literature study: 10 hours. b) Work on preparing the project: 25 hours. 3) TOTAL – 110 hours.
Number of ECTS points for classes requiring direct participation of members of academic staff:	3 ECTS points – number of contact hours - 75 hours of a project.
Number of ECTS points obtained by a student within practical classes:	4 ECTS points - 100 hours of student's work, including: a) participation in project practicals - 75 hours; b) work on preparing the project – 25 hours;
E. Additional information	
Comments	

TABLE No 62. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Knows how to obtain data from literature; can evaluate the operation of rules and laws concerning intellectual property protection.
Code:	1150-MT000-ISA-0328_*W1*
Verification:	*Interim thesis*
Connected field of study outcome	K_W22
Skills	
Outcome:	Can design a simple device, system or process, using proper methods, techniques and tools, considering the use of proper materials and technologies necessary in the production process.
Code:	1150-MT000-ISA-0328_*U1*
Verification:	*Interim thesis*
Connected field of study outcome	K_U21, K_U14, K_U11
Outcome:	Can perform an initial economic analysis of designed construction solutions or processes.
Code:	1150-MT000-ISA-0328_U2
Verification:	*Interim thesis*
Connected field of study outcome	K_U09
Outcome:	Can obtain data from literature and data bases, can evaluate the operation of rules and laws of intellectual property protection and can prepare a clear report or presentation discussing advantages and disadvantages of different solutions.
Code:	1150-MT000-ISA-0328_U3
Verification:	*Interim thesis*
Connected field of study outcome	K_U01, K_U03, K_U04
Social Competences	
Outcome:	Is aware of the role of a graduate in conveying the achievements in mechatronics of vehicle and construction machinery to the society.
Code:	1150-MT000-ISA-0328_K1
Verification:	*Interim thesis*
Connected field of study outcome	K_K02, K_K04, K_K06

Description of a Subject	
SUBJECT: APPRENTICESHIP	
Subject code	1150-MT000-ISA-0329
Subject version	Version I
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics
Profile of study	General academic
Degree program	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering
Performing unit	Faculty of Automotive and Construction Machinery Engineering
B. General characteristics of the subject	
Subject kind	Basic
Subject group	Compulsory
Subject level	Intermediate
Subject status	Compulsory
Language of instruction	English
Nominal semester	VI
Pre-requisites	Individual or group realization during the time free from other classes (preferably holidays).
Limit of number of students	
C. Learning outcomes and the manner of conducting classes	
Aim of the subject	The aim of the professional practice is for a student to learn practical aspects related to the profile of study in the Faculty, e.g.: • modern methods of design, modelling, production and verification in machine industry or electrical engineering within the scope of : - production preparation, structure and construction of systems and products, design of technological processes, construction of equipment; - different ways of producing goods e.g. machining, or forming process, - use, logistics, diagnostics device and repair of vehicles, rail vehicles and construction machinery; • CAD/CAM computer-aided, iterated systems; • systems ensuring quality of goods, general technical safeguards (Safety Rules and Regulations); • mechatronic, pneumatic, hydraulic power train systems (e.g. controlling, forming or regulating) in vehicles, construction machinery, mechanisms and assistive devices; • studies of active and passive safety of goods, durability and reliability of load bearing structures of machines and vehicles, chassis, braking systems etc.,; • automation of vehicle and machine operation, single- and dual- (hybrid) source power trains, participation in research or implementation projects; • recycling, ecology and environmental protection against the effects of use, malfunction or repair of vehicles, construction machinery and electro-mechanical and mechatronic devices etc.

Learning outcomes	See **TABLE No 63**	
Form of classes and their duration	Student professional practice	4 weeks (160 h)
Learning content	The content of the practice is establishes individually, according to the chosen degree programn and may take different forms, depending on the specification of a unit (its profile). For example, for Vehicles degree program, the Program comprises: production and assembly technology of car parts, vehicle diagnostics, study of transmission systems etc.; whereas for Computer Aided Engineering degree program Projects: CAD construction and design, methods of MES, MEM engineering calculations, databases, CAD-CAM, work in construction office etc. Students doing practice in MZA in Warsaw experience 3-4 work posts, where they: - learn tasks connected with organization of particular department of a company - instruction for working on a particular post - work under an assigned Supervisor. It is preferred to choose a unit, which enables to perform work within the degree program, chosen by a student and according to student's interest. The character of professional practice ought to comply with the field of study and Dean's Representative for Professional Practice has to accept the performing unit chosen by a student, on condition that it fulfills professional practice requirements.	
Evaluation methods	Verbal evaluation: pass/fail Student's report on professional practice is evaluated, an employer also evaluates a student. In particular cases, a student may obtain a pass from professional practice based on a document confirming: performed practice, internship, professional work, on condition that it fulfills requirements of professional practice. Pass is granted by the Representative for Professional Practice.	
Ways of verifying learning outcomes	See **TABLE No 63**	
Exam	No	
D. Student's contribution		
Number of ECTS points	4	
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours - 161 hours , including/and practice – 160 h; consultation – 1 h. 2) TOTAL – 161 hours.	
Number of ECTS points for classes requiring direct participation of members of academic staff:		
Number of ECTS points obtained by a student within practical classes:	6,6 ECTS points – 165 hours of student's individual work, including: a) participation in a hiring unit – 160 h; b) preparing report on practice and its acceptance - 5 h.	
E. Additional information Duration of professional practice – 4 weeks (160 hours during the time free from other classes)		
Comments		

TABLE No 63. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Is aware of the need to develop knowledge within the chosen field of study. Is able to recognize the labor market connected with particular interests (study) near the place of residence or in Warsaw.
Code:	1150-MT000-ISA-0329_W1
Verification:	Evaluation of report on professional practice course.
Connected field of study outcome	K_ W17,K_W20, K_W21
Outcome:	Learns about work organization and rules, uses traditional and modern was of performing assigned tasks – available and applied in the hiring unit.
Code:	1150-MT000-ISA-0329_W2
Verification:	Evaluation of report on professional practice course.
Connected field of study outcome	K_ W17,K_W20, K_W21
Skills	
Outcome:	Knows how to perform assigned employee tasks, perform and solve tasks assigned by an employer, obtain information from literature, databases and other sources in order to self-educate e.g. in order to improve professional competences.
Code:	1150-MT000-ISA-0329_U1
Verification:	Evaluation of report on professional practice course.
Connected field of study outcome	K_U19, K_U22, K_U24, K_U23, K_U21
Outcome:	Can identify processes used in the hiring unit, can work individually and cooperate with a team, in an industrial environment, showing discipline, responsibility and an appropriate attitude, and complying with job-related safety rules and regulations. Can estimate the time needed to perform an assigned task; can prepare and perform a work schedule, ensuring deadlines are kept.
Code:	1150-MT000-ISA-0329_U2
Verification:	Evaluation of report on professional practice course.
Connected field of study outcome	K_U19, K_U22, K_U24, K_U23, K_U21
Outcome:	Can prepare and give a short presentation devoted to outcomes of realization of an established engineering task.
Code:	1150-MT000-ISA-0329_U3
Verification:	Evaluation of report on professional practice course.
Connected field of study outcome	K_U19, K_U22, K_U24, K_U23, K_U21
Social competences	
Outcome:	Understands the need and knows the possibilities of constant self-study, improving professional, personal and social competences, thinking and acting in a creative and entrepreneurial way.
Code:	1150-MT000-ISA-0329_K01
Verification:	Evaluation of report on professional practice course.
Connected field of study outcome	K_01; K_02; K_03; K_04; K_05; K_06
Outcome:	Has competences and awareness of responsibility for individual work, organization and readiness to comply with rules of team work and improving responsibility for commonly realized goals as part of conceptual and practical actions as well as cooperation with the Practice Supervisor.
Code:	1150-MT000-ISA-0329_K02

Verification:	Evaluation of report on professional practice course.
Connected field of study outcome	K_01; K_02; K_03; K_04; K_05; K_06

Description of a Subject		
SUBJECT: RELIABILITY AND SAFETY OF MECHATRONIC SYSTEMS		
Subject code	1150-MTR-ISA-0431	
Subject version	Version 1	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Connected with the field of study	
Subject level	Intermediate	
Subject status	Subject of limited choice	
Language of instruction	English	
Nominal semester	7	
Pre-requisites	Knowing basics of differential calculus, integral calculus and calculus of probability.	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Learning about: constructing reliable statistical models, life cycle of devices, objects and technical systems from reliability approach perspective, correlation between technical risk and probability of damage occurrence and size of losses. Learning basic methods of technical risk analysis.	
Learning outcomes	See **TABLE No 64**	
Form of classes and their duration	Lecture	30
	Practicals	0
	Laboratory	0
	Project	0
Learning content	Presenting subject content, discussing recommended literature and rules for obtaining credit for the course. Introduction to Reliability and Safety of Complex Objects, basic terms. Risk management. Risk assessment. Aspects of statistics used in Reliability and Safety of Complex Objects. Functions characteristic of reliability. Expotential and Weibuille distribution. Functions of system structure – sets of paths and cuts. Qualitative methods of risk evaluation. Fault-tree analysis. Analysis of occurrences. Test. FMEA – Analysis of effects of fault (damage) occurrence. Application of FMEA method in risk analysis. Qualitative risk assessment. Simulation methods. Analytical methods of reliability assessment (physical models). Calculating average damage occurrence time (MTTF). Macromodels. Making decisions in uncertain conditions. Test.	
Evaluation methods	Credit for the lecture is granted based on two tests and two homework.	
Ways of verifying learning outcomes	See **TABLE No 64**	

Exam	No
D. Student's contribution	
Number of ECTS points	2
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours - *32 h including:* a) lecture -30 h; b) consultations - 2 h; 2. Student's individual work – 18 hours, including: a) 3 h – current intake of knowledge presented during lectures (literature analysis), b) 6 h – doing homework, c) 8 h- preparing for tests, 3) TOTAL – 50 hours
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,28 ECTS points - number of contact hours - 32 h including: a) lecture -30 h; b) consultations - 2 h;
Number of ECTS points obtained by a student within practical classes:	
E. Additional information	
Comments	

TABLE No 64. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Knows how to build reliable statistical models (characteristic reliability functions – expotential and Weibuille distribution), knows basic terms connected with reliability and safety of technical systems (reliability, risk, acceptable risk, risk assessment and analysis).
Code:	1150-MTR-ISA-0431_W1
Verification:	Written or oral form by answering questions (test/homework).
Connected field of study outcome	K_W01, K_W15
Outcome:	A student has basic knowledge of reliability assessment methods (logic and FMEA models) and of decision making in uncertain conditions (game theory).
Code:	1150-MTR-ISA-0431_W2
Verification:	Written or oral form by answering questions (test/homework).
Connected field of study outcome	K_W15, K_W21
Skills	
Outcome:	A student can establish reliability structure of complex objects.
Code:	1150-MTR-ISA-0431_U1
Verification:	Written or oral form by solving an assigned problem by means of homework or during a test.
Connected field of study outcome	K_U01, K_U02.
Outcome:	A student can establish reliability index and probability of damage occurrence for a simple construction.
Code:	1150-MTR-ISA-0431_U2
Verification:	Written or oral form by solving an assigned problem by means of homework or during a test.
Connected field of study outcome	K_U01, K_U07.

Description of a Subject		
SUBJECT: PLM – DATABASE APPROACH		
Subject code	1150-MT000-ISA-427	
Subject version		
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program	-	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Connected with the field of study	
Subject level	Intermediate	
Subject status	Subject of limited choice	
Language of instruction	English	
Nominal semester	VII	
Pre-requisites	Programming using Visual Basic language (basic level). Knowing Windows.	
Limit of number of students	30	
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Learning about the idea of product lifecycle management (PLM) and some techniques of its practical implementation related to relational databases. Learning to build logical relational databases. Learning the basics if SQL language. Learning methods and techniques of creating relational applications of databases in object oriented graphic environments, Access software in particular.	
Learning outcomes	See **TABLE No 65**	
Form of classes and their duration	Lecture	30 h
	Practicals	0
	Laboratory	0
	Project	0
Learning content	Data processing in industry. Structure of data acquisition and processing. ISA-065 Norm. ERP and MES systems. Product data management during its lifecycle (PLM) – idea, sources and historical development, as well as modern application examples. Techniques for searching and analysis of large data resources. Fourth industrial revolution – network integration of processes and products. Role of relational databases in creating integrated areas of human activity. Development tendencies. Idea and basic concepts of relational database model. Relational database as a model of a real system. Modelling techniques. Examples of modelling of engineering problems using relational formalism. Normalization of logic structures. Typical solutions in chart projects. Database applications: typical architecture solutions and strategies for using local and network data sources. Object orientation. Idea of creating database applications in Visual Studio environment. ADO.NET architecture. Separate data	

	model: advantages, disadvantages, consequences of solution. Techniques for ensuring data safety. Integration of relational databases and spreadsheets. Kinds of operations in relational database. SQL language – idea and basic terms. Selecting queries. Internal and external chart connections. Aggregate queries. Functional queries. Graphic aid for creating SQL language queries. Query-by-Example technique and its implementation in Microsoft Access software. Parametric queries. Transverse queries. Graphic, object oriented environments of relational database application design – idea, function scope and use. Controlling application using occurrences. Form as a basic element of user interface. Forms connected with data sources: techniques for design and select data sources. Related, unrelated and calculated components. Mapping of *one to many* dependencies using user interface forms. Creating printed documentation. Reports: roles and design methods. Sorting and grouping data. Creating summaries. Report preview and printing.
Evaluation methods	1. Analysis of students' activity during lecture, posed questions and expressed doubts. 2. Evaluation of tasks performed by students during classes. 3. Two written tests.
Ways of verifying learning outcomes	See **TABLE No 65**
Exam	Does not apply
D. Student's contribution	
Number of ECTS points	2
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours - 32 h including: a) Lecture – 30h; b) Consultations – 2h; 2) Student's own work – 18h including: a) literature study - 8 h; b) preparing for tests -10 h; 3) TOTAL – 50.
Number of ECTS points for classes requiring direct participation of members of academic staff:	2) 1,28 ECTS points – number of contact hours - 32 h including: a) Lecture – 30h; b) Consultations – 2h;
Number of ECTS points obtained by a student within practical classes:	0.25 ECTS point – 6 hours of classes with computers: work on creating a project of a simple database and elements of interface of its applications in graphic environment of Microsoft Access software.
E. Additional information	
Comments	

TABLE No 65. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Has basic knowledge in the field of production process data management and processing, product service during its lifecycle, is aware of the role of relational databases in the process.
Code:	1150-MT000-ISA-427_W1
Verification:	Test
Connected field of study outcome	K_W14, K_W15

Outcome:	Knows how to create relational models of real systems (modelling so information sources relating to system elements and information relations among resources connected with different kinds of elements).
Code:	1150-MT000-ISA-427_W2
Verification:	Test
Connected field of study outcome	K_W14, K_W15
Outcome:	Knows types of database application structures and major kinds of their architecture.
Code:	1150-MT000-ISA-427_W3
Verification:	Test
Connected field of study outcome	K_W14, K_W15
Outcome:	Has general knowledge in relational integration techniques of databases and spreadsheets.
Code:	1150-MT000-ISA-427_W4
Verification:	Test
Connected field of study outcome	K_W21.
Skills	
Outcome:	Can design relational structures of information resources for real systems.
Code:	1150-MT000-ISA-427_U1
Verification:	Test
Connected field of study outcome	K_U01
Outcome:	Can create commands od data operation in SQL language.
Code:	1150-MT000-ISA-427 _U2
Verification:	Test
Connected field of study outcome	K_U01
Outcome:	Can create SQL queries using Query-by-Example technique.
Code:	1150-MT000-ISA-427 _U3
Verification:	Test (within the scope of method idea), practical verification of skills during work with computer
Connected field of study outcome	K_U01
Outcome:	Knows rules for using graphic environments of designer work of relational databases applications.
Code:	1150-MT000-ISA-427_U4
Verification:	Test (within the scope of general methods of solving typical problems), practical verification of skills during work with computer
Connected field of study outcome	K_U01
Outcome:	Can design simple forms and reports being a part of database application user interface
Code:	1150-MT000-ISA-427_U5
Verification:	Test (within the scope of knowing typical templates for architecture solutions of these objects), practical verification of skills during work with computer
Connected field of study outcome	K_U01
Social Competences	
Outcome:	Is aware of the need to protect the content of database against unauthorized use.
Code:	1150-MT000-ISA-427 _K1
Verification:	Test (within the scope of typical safeguards), discussion
Connected field of	K_K02

study outcome	

Description of a Subject		
SUBJECT: DIPLOMA SEMINAR		
Subject code	1150-00000-ISA-0605	
Subject version	1	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program	-	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Connected with the field of study	
Subject level	Advanced	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	7	
Pre-requisites		
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Preparing students to execute diploma thesis and diploma presentation. Preparing students for diploma exam.	
Learning outcomes	See **TABLE No 66**	
Form of classes and their duration	Lecture	
	Practicals	15
	Laboratory	
	Project	
Learning content	Practicals: Requirements for B.Sc. thesis. Student's own contribution. Rules for preparing Diploma Thesis Sheet. General structure and content of particular parts of diploma thesis. Rules for editing diploma thesis and for using proper terminology. Formulating tasks, aim and scope of diploma thesis. Preparing synopsis and references. Abiding by copyright laws. Diploma thesis aesthetics. Rules for conducting diploma exam. Ruled for conducting factual discussions. Rules for preparing diploma presentation: number and layout of slides, their content and coherence. Rules for giving a presentation.	
Evaluation methods	Evaluation of presentation, student's active participation in seminar.	
Ways of verifying learning outcomes	See **TABLE No 65**	
Exam	No	
D. Student's contribution		
Number of ECTS points	1	
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours - 16 h including: a) Practicals – 15 h; b) Consultations – 1h; 2) Student's individual work – 9 hours, including: a) literature study: 4 h	

	b) preparing presentation: 5 h 3) TOTAL – 25 h
Number of ECTS points for classes requiring direct participation of members of academic staff:	0,64 ECTS point – 16 h including: c) Practicals – 15 h; d) Consultations – 1h;
Number of ECTS points obtained by a student within practical classes:	0,8 ECTS point - 20 hours, including: a) participation in practicals – 15h; b) preparing presentation – 5 h.
E. Additional information	
Comments	

TABLE No 66. SUBJECT OUTCOMES	
Knowledge	
Outcome:	A student who has passed the subject knows rules for B.Sc. thesis layout and presenting its results in a clear and understandable manner. He or she also has basic knowledge in the area of patent laws and intellectual property resources management.
Code:	1150-00000-ISA-0605_*W1*
Verification:	Evaluation of presentation
Connected field of study outcome	K_W22
Skills	
Outcome:	Can practically apply rules concerning intellectual property protection.
Code:	1150-00000-ISA-0605_U1
Verification:	Evaluation of presentation
Connected field of study outcome	K_U01, K_U06
Outcome:	A student can: • Analyze the state of knowledge of the scientific literature and other sources recommended for a given topic, • Critically evaluate the knowledge and formulate the results in the form of a short report.
Code:	1150-00000-ISA-0605_U2
Verification:	Evaluation of presentation
Connected field of study outcome	K_U01, K_U03, K_U02, K_U04, K_U06
Social Competences	
Outcome:	Is aware of the role of a graduate in conveying the achievements in mechanics and machine construction to the society.
Code:	1150-00000-ISA-0605_K1
Verification:	Evaluation of presentation
Connected field of study outcome	K_K02, K_K04, K_K06

Description of a Subject	
SUBJECT: THESIS	
Subject code	1150-MT000-ISA-0420
Subject version	1s
A. Placing the subject within the study system	
Level of study	I degree

Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program	-	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the field of study	
Subject group	Connected with the field of study	
Subject level	Advanced	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	7	
Pre-requisites		
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	The aim of the subject is student's execution of an B.Sc. thesis	
Learning outcomes	See **TABLE No 67**	
Form of classes and their duration	Lecture	
	Practicals	
	Laboratory	
	Project	150
Learning content	The subject comprises student's own work in the scope indISAensable to execute a B.Sc. thesis, established in agreement with the Thesis Supervisor. Topic of the thesis ought to be connected with student's field of study. B.Sc. thesis ought to exhibit author's ability to solve problems, based on knowing theoretical bases or empirical analyses and the use of known methods, analyses and/or softwares connected with considered issue. B.Sc. thesis ought to contain solution to the problem assigned to the author based on available literature. The object of the thesis may be especially: solving a project , production or use problem of technical devices and objects, conducting research together with analysis of obtained results, preparing a software with an appropriate level of difficulty.	
Evaluation methods	Thesis Supervisor's evaluation of the B.Sc. thesis	
Ways of verifying learning outcomes	See **TABLE No 67**	
Exam	No	
D. Student's contribution		
Number of ECTS points	15	
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours - 150 h of project. 2) Student's individual work – 235 h including: a) literature study: 10 h; b) preparing B.Sc. thesis: 225 h. 3) TOTAL – 385 h	
Number of ECTS points for classes requiring direct participation of members of academic staff:	6 ECTS points – 150 h of project	
Number of ECTS points obtained by a student within practical classes:	15 ECTS points - 375 h of student's individual work, including: a) participation in project - 150 h; b) preparing B.Sc. thesis – 225 hours.	
E. Additional information		
Comments		

TABLE No 67. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Knows how to obtain data from literature and data bases; can evaluate the operation of rules and laws concerning intellectual property protection. Has a well-ordered knowledge in the field of mechatronics of vehicles and its aware of its current condition and development trends.
Code:	1150-MT000-ISA-0420_*W1*
Verification:	Thesis Supervisor's evaluation of the B.Sc. thesis
Connected field of study outcome	K_W22, K_W19
Skills	
Outcome:	Can design a simple device, system or process, using proper methods, techniques and tools, considering the use of proper materials and technologies necessary in the production process.
Code:	1150-MT000-ISA-0420_*U1*
Verification:	Thesis Supervisor's evaluation of the B.Sc. thesis
Connected field of study outcome	K_U21, K_U14, K_U11
Outcome:	Can perform an initial economic analysis of designed construction solutions or processes.
Code:	1150-MT000-ISA-0420_U2
Verification:	Thesis Supervisor's evaluation of the B.Sc. thesis
Connected field of study outcome	K_U09
Outcome:	Can obtain data from literature, data bases, and other sources within the scope of the field of study; can evaluate the operation of rules and laws of intellectual property protection.
Code:	1150-MT000-ISA-0420_U3
Verification:	Thesis Supervisor's evaluation of the B.Sc. thesis
Connected field of study outcome	K_U01, K_U03, K_U04
. **Social Competences**	
Outcome:	Is aware of the role of a graduate in conveying the achievements in mechatronics of vehicle and construction machinery to the society.
Code:	1150-MT000-ISA-0420_K1
Verification:	Thesis Supervisor's evaluation of the B.Sc. thesis
Connected field of study outcome	K_K02, K_K04, K_K06

Description of a Subject	
SUBJECT: VEHICLE MECHATRONICS	
Subject code	1150-MT000-ISA-0321
Subject version	1
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery
Profile of study	General academic
Degree program	Vehicle Mechatronics, Vehicle and Construction Machinery Mechatronics
Supervising unit	Faculty of Automotive and Construction Machinery Engineering
Performing unit	Faculty of Automotive and Construction Machinery Engineering

B. General characteristics of the subject		
Subject kind	Connected with the degree program	
Subject group	Connected with the degree program	
Subject level	Intermediate	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	6	
Pre-requisites	Knowing basics of mechatronics, electronics and physics.	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	The aim of the course is to teach students construction and operation of vehicle mechatronic systems, and teach them to perform measurements and diagnostics of basic mechatronic systems.	
Learning outcomes	See **TABLE No 68**	
Form of classes and their duration	Lecture	30 h
	Practicals	
	Laboratory	15 h
	Project	
Learning content	Lecture: general knowledge concerning operation, construction and application examples: sensors, actuators – overview; ZI engine powering and control systems; ZS engine powering and control systems; On-board diagnostics; Engine charging systems; Advanced braking systems - BAS etc.; Advanced control systems (variable timing gear phases etc.); Modern power train transmission system (dual mass flywheel, self-adjusting clutch etc.); Advanced steering techniques; ZI engine universal controllers; Injections maps; Controlling alternative fuel injection installations; Construction of control systems of multi-fuel engines; Autonomous platforms; Precision agriculture; Advanced solutions for automatic and semi-automatic gearboxes; Active suspensions (hydro pneumatic etc.); ACC systems. Laboratory: practical operation and diagnostics of mechatronic systems. Integrated Motronic engine type control system. Steering system with hydraulic-electric support. Mechatronic control of Common Rail ZS engine. Evaluation of operation parameters of a multi-fuel engine. Study of engine controller injection maps. Programming of universal ZI controllers. Examining car geometry.	
Evaluation methods	**Lecture**: credit granted based on written exam **Laboratory:** Before starting each exercise, students' preparation is checked (so called 'entry quiz'). Pass for each exercise is granted based on a prepared report, accepted and evaluated by the person conducting a given exercise.	
Ways of verifying learning outcomes	See **TABLE No 68**	
Exam	Yes	
D. Student's contribution		
Number of ECTS points	4	
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours - 48 h, including:, a) lecture - 30 h; b) laboratory- 15 h.; c) consultations - 3 h; 2) Student's individual work – 52 h, including: a) literature study: 12 h; b) preparation for classes: 14 h; c) preparation for exam: 16 h; d) preparing reports: 10 h. 3) TOTAL – 100 h.	

Number of ECTS points for classes requiring direct participation of members of academic staff:	*1,92* ECTS points – number of contact hours - 48 h, including:, a) lecture - 30 h; b) laboratory- 15 h.; c) consultations - 3 h;
Number of ECTS points obtained by a student within practical classes:	1 ECTS point - 25 h of student's individual work, including: a) participating in laboratory exercises - 15 h; b) preparing laboratory report - 10 h.
E. Additional information	
Comments	

TABLE No 68. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Knows construction and operation of vehicle mechatronic systems.
Code:	1150-MT000-ISA-0321_W1
Verification:	Exam
Connected field of study outcome	K_W17, K_W18
Outcome:	Knows basics of vehicle mechatronic system diagnostics.
Code:	1150-MT000-ISA-0321_W2
Verification:	Exam, oral test before admitting to perform exercises, evaluation of reports.
Connected field of study outcome	K_W20
Outcome:	Knows development trends of contemporary vehicle mechatronic systems.
Code:	1150-MT000-ISA-0321_*W3*
Verification:	Exam, oral test before admitting to perform exercises, evaluation of reports.
Connected field of study outcome	K_W19
Skills	
Outcome:	Can perform diagnostics of mechatronic systems used in vehicles and establish their influence on endangering the environment.
Code:	1150-MT000-ISA-0321_*U1*
Verification:	Oral test before admitting to perform exercises, evaluation of reports.
Connected field of study outcome	K_U11, K_U12, K_U13, K_U14, K_U15, K_U16, K_U17, K_U18, K_U20
Social Competences	
Outcome:	Can work individually and in a team.
Code:	1150-MT000-ISA-0321_*K1*
Verification:	Evaluating tasks while doing exercises, evaluation of reports.
Connected field of study outcome	K_K04

Description of a Subject	
SUBJECT: VEHICLE POWER TRAINS	
Subject code	1150-MTPOJ-ISA-0321
Subject version	Version 1
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery
Profile of study	General academic
Degree program	Vehicle Mechatronics

Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the degree program	
Subject group	Connected with the degree program	
Subject level	Intermediate	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	6	
Pre-requisites	Basic knowledge of general mechanics, basics of machine construction and vehicle mechanics.	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Learning bases of vehicle power train theory, basics of construction, solutions and rules of operation and rules for calculating this type of system. Gaining a skill of selection of a kind and basic parameters of power train, and its system for a given vehicle.	
Learning outcomes	See **TABLE No 69**	
Form of classes and their duration	Lecture	30 h
	Practicals	-
	Laboratory	15 h
	Project	-
Learning content	**Lecture**. Kinds, functions and parameters of a power train system. Vehicle power train system as a transducer of rotational speed and torque. Comparing the demand for vehicle power with engine power – required characteristics of power train system. Kinematic and dynamic transmission. Transmission change: gradual and constant; with stopping power transmission and under strain. Choice of transmissions. Mechanical power train system. Idea of mechanical power train system in different vehicles. Constructions and control principle. System and mechanism components and their distribution. Discussing basic parameters, rules for designing and construction of friction clutch, mechanical gearboxes, synchronizers, articulated drive shafts, axles, differentials. Basics for project calculating of chosen systems. Controlling mechanical power train system. Automated and automatic gearboxes. Examples of solutions. **Laboratory.** Characteristics of towing power of a tractor. Bench testing of gears under strain. Study of mechanical gearbox efficiency. Study of a vehicle on a chassis dynamometer. Establishing blocks of equivalent strains for bench testing of axle	
Evaluation methods	**Lecture:** credit granted based on written exam **Laboratory:** Before starting each exercise, students' preparation is checked (so called 'entry quiz'). Pass for each exercise is granted based on a prepared report, accepted and evaluated by the person conducting a given exercise**.**	
Ways of verifying learning outcomes	See **TABLE No 69**	
Exam	No	
D. Student's contribution		
Number of ECTS points	3	
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours - 48*, including:* a) lecture – 30 h; b) laboratory – 15 h.; c) consultations – 3 h; 2) Student's individual work - 27 h, including: a) 4 h – current preparation for lecture;	

	b) 4 h – literature study; c) 6 h – preparing for tests; d) 6 h – preparing for exercises; e) 7 – preparing reports. 3) TOTAL – 75 h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,92 ECTS points – number of contact hours - 48, including: a) lecture – 30 h; b) laboratory – 15 h.; c) consultations – 3 h;
Number of ECTS points obtained by a student within practical classes:	1,12 ECTS points – 28 h, including: 1) laboratory exercises – 15 h; 2) 6 h – preparing for laboratory exercises; 3) 7 h – preparing results and reports.
E. Additional information	
Comments	

TABLE No 69. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Knows criteria for design of vehicle power train systems arising from their analysis and possible damages.
Code:	1150-MTPOJ-ISA-0321_W1
Verification:	Tests
Connected field of study outcome	K_W17; K_W18; K_W19; K_W20
Outcome:	Has well-ordered and theoretically based general knowledge in key issues of construction and theory of vehicle power trains.
Code:	1150-MTPOJ-ISA-0321_W2
Verification:	Tests, oral test before admitting to performing exercise, evaluation of reports.
Connected field of study outcome	K_W17; K_W18; K_W19; K_W20
Outcome:	Knows basic calculation and experimental methods used while solving simple problems related to vehicle power train systems.
Code:	1150-MTPOJ-ISA-0321_W3
Verification:	Tests, oral test before admitting to performing exercise, evaluation of reports.
Connected field of study outcome	K_W17; K_W18; K_W19; K_W20
Outcome:	Knows materials used in vehicle power trains and their basic mechanical properties, arising from technological process.
Code:	1150-MTPOJ-ISA-0321_W4
Verification:	Tests.
Connected field of study outcome	K_W17; K_W18; K_W19; K_W20
Outcome:	Knows how to establish and determine project strains and their effects, indISAensable to design vehicle power train systems.
Code:	1150-MTPOJ-ISA-0321_W5
Verification:	Tests, oral test before admitting to performing exercise, evaluation of reports.
Connected field of study outcome	K_W17; K_W18; K_W19; K_W20
Skills	
Outcome:	Can conduct basic calculations power train systems and formulate appropriate project criteria.
Code:	1150-MTPOJ-ISA-0321_U1
Verification:	Tests

Connected field of study outcome	K_U15; K_U16; K_U17; K_U18
Outcome:	Can establish and design project strains for basic systems of vehicle power train.
Code:	1150-MTPOJ-ISA-0321_U2
Verification:	Tests, oral test before admitting to performing exercise, evaluation of reports.
Connected field of study outcome	K_U15; K_U16; K_U17; K_U18
Outcome:	Can select parameters of systems of vehicle power train for a given vehicle.
Code:	1150-MTPOJ-ISA-0321_U3
Verification:	Tests, oral test before admitting to performing exercise, evaluation of reports.
Connected field of study outcome	K_U15; K_U16; K_U17; K_U18
Social Competences	
Outcome:	Can cooperate and work in a group while performing laboratory exercises and preparing reports, assuming different roles.
Code:	1150-MTPOJ-ISA-0321_K1
Verification:	Evaluation of performed tasks while doing exercises, evaluation of reports.
Connected field of study outcome	K_K04

Description of a Subject		
SUBJECT: ON-BOARD DIAGNOSTICS OF VEHICLES		
Subject code	1150-MTMTR-ISA-0407	
Subject version		
A. Placing the subject within the study system		
Level of study	I degree study	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program	Vehicle mechatronics	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the degree program	
Subject group	Connected with the degree program	
Subject level	Intermediate	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	VII	
Pre-requisites	Knowing construction of vehicle systems under electronic control. Knowing practical applications of construction solutions of these systems. Knowing basic laws of general electrical engineering.	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	The aim of the subject is to teach students how to detect and signal faults in electronically controlled vehicle systems. Methodology of fault search based on symptoms and signaled codes. Planning procedures of fault detection.	
Learning outcomes	See **TABLE No 70**	
Form of classes and their duration	Lecture	30 h
	Practicals	
	Laboratory	15 h

	Project	
Learning content	**Lecture:** 1. Preliminary issues. Electronic control systems in modern automobiles. 2. General rules for fault detection. Typical diagnostic equipment. Multiplexed communication in an automobile. 3. Diagnostics of engine control systems – fuel injection, ignition, filling control systems, other control systems of spark ignition engines. 4. Speed control of idle gear rotational speed and electronically controlled throttles. ZI engine with direct fuel injection. 5. Application of technology of ZI engine fuel injection control for ZS engines – similarities and differences. 6. Systems for limiting emission of harmful elements of exhaust fumes in ZI and ZS engines. 7. Control of automatic power train systems. Control of automated gearboxes. 8. Electronic control in steering system. 4-wheel steering system. 9. ABS, ABD etc. braking support systems. 10. Systems preventing side slips and systems controlling drive force. 11. Electronically controlled suspension systems, control of suppression and stiffness. 12. Passive safety systems – airbags, seat belts. 13. Anti-theft safeguards – alarm, immobilizer. 14. Comfort systems and their control, use of GSM and GPS. 15. Other chosen systems in an automobile 16. Final class (summary of the course, obtaining credit). **Laboratory:** Learning operation principle and vehicle system diagnostics in a practical manner. 1. Diagnostics of ABS/ASR braking force control system. 2. Diagnostics of SRS passive safety system. 3. Diagnostics of a BMW automobile. 4. GM engine diagnostics. 5. Serial and parallel diagnostics – ADP 196 diagnostic tester. 6. Diagnostics of an internal combustion engine. 7. Simulation study of catalytic converter. 8. Computer diagnostics of self-ignition engine charging system. 9. ZS engine diagnostics based on indicator diagram. 10. Mobile applications for on-board diagnostics.	
Evaluation methods	Lecture: evaluation of presentation. Laboratory: evaluation of reports on performed laboratory exercises.	
Ways of verifying learning outcomes	See **TABLE No 70**	
Exam	No	
D. Student's contribution		
Number of ECTS points	3	
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours- *48,* including: a) lecture - 30 h; b) laboratory - 15 h; c) consultations – 3 h. 2) Student's individual work – 27 hours, including: a) 3 h – literature study, b) 4 h – preparation for classes, c) 5 h – preparing for laboratory, d) 10 h – preparing reports, e) 5 h – preparing 2 presentations. 3) TOTAL –75 h	

Number of ECTS points for classes requiring direct participation of members of academic staff:	1,92 ECTS points – number of contact hours- 48, including: a) lecture - 30 h; b) laboratory - 15 h; c) consultations – 3 h.
Number of ECTS points obtained by a student within practical classes:	1 ECTS point – 25 h including: a) laboratory – 15 h; b) 10 h – preparing laboratory reports.
E. Additional information	
Comments	

TABLE No 70. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Knows construction of electronically controlled automobile systems.
Code:	1150-MTMTR-ISA-0407_W1
Verification:	Evaluation of presentation
Connected field of study outcome	K_W17, K_W18, K_W19, K_W20.
Outcome:	Knows practical applications of construction solutions of these systems.
Code:	1150-MTMTR-ISA-0407_W2
Verification:	Evaluation of presentation
Connected field of study outcome	K_W17, K_W18, K_W19, K_W20.
Outcome:	Knows basic laws of general electrical engineering.
Code:	1150-MTMTR-ISA-0407_W3
Verification:	Evaluation of presentation
Connected field of study outcome	K_W17, K_W18, K_W19, K_W20.
Skills	
Outcome:	Can interpret and solve problems of detection and signaling of faults in electronically controlled automobile systems.
Code:	1150-MTMTR-ISA-0407_U1
Verification:	Evaluation of report on laboratory exercise.
Connected field of study outcome	K_U15, K_U16, K_U17, K_U18.
Outcome:	Can apply methodology of searching for faults based on symptoms and signaled codes.
Code:	1150-MTMTR-ISA-0407_U2
Verification:	Evaluation of report on laboratory exercise.
Connected field of study outcome	K_U15, K_U16, K_U17, K_U18.
Outcome:	Can plan procedures for fault detection.
Code:	1150-MTMTR-ISA-0407_U3
Verification:	Evaluation of report on laboratory exercise.
Connected field of study outcome	K_U15, K_U16, K_U17, K_U18.
Social Competences	
Outcome:	Can cooperate and work in a group while performing laboratory exercises and preparing report, assuming different roles.
Code:	1150-MTMTR-ISA-0407_K1
Verification:	Evaluation of tasks performed while doing exercises, evaluation of report
Connected field of study outcome	K_K04, K_K02

Description of a Subject		
SUBJECT: AUTONOMOUS VEHICLES		
Subject code	1150-MTMTP-ISA-0405	
Subject version	Version I	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program	Vehicle mechatronics	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the degree program	
Subject group	Connected with the degree program	
Subject level	Intermediate	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	7	
Pre-requisites	Knowing mechanics, and basics of automation	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Introduction to issues related to autonomous vehicles, considering historical aspect, current state of knowledge and potential challenges, as well as presenting chosen aspects of control algorithms and data fusion.	
Learning outcomes	See **TABLE No 71**	
Form of classes and their duration	Lecture	30
	Practicals	-
	Laboratory	-
	Project	-
Learning content	History of development of autonomous vehicles, current state of knowledge as well as problems and challenges engineers are facing. Gauges and sensors of autonomous vehicles, their properties and application in autonomous vehicles. Methods of signal fusion, application of Klaman filter. Methods of controlling non-linear systems, backstepping method (backward integration). Overview of algorithms preforming basic tasks for autonomous vehicles such as tracking or reaching destination.	
Evaluation methods	Marks obtained for performed computer programs (homework), presentations.	
Ways of verifying learning outcomes	See **TABLE No 71**	
Exam	No	
D. Student's contribution		
Number of ECTS points	3	
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours - 32, a) lectures -30 h; b) consultations - 2 h; 2. Student's individual work – 45 hours, including: a) 15 h – current preparation for lectures (literature analysis), b) 20 h – doing homework,	

	c) 10 h – preparing a presentation , 3) TOTAL – 77 hours
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,28 ECTS points - number of contact hours - 32, a) lectures -30 h; b) consultations - 2 h;
Number of ECTS points obtained by a student within practical classes:	*0,8* ECTS point- *20* h, including: a) 20 h – doing homework
E. Additional information	
Comments	

TABLE No 71. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Learning basic aspects relating to autonomous vehicles, current state of affairs, history and challenges.
Code:	1150-MTMTP-ISA-0405_W1
Verification:	Evaluation of the quality of prepared presentation.
Connected field of study outcome	K_W13, K_W19
Outcome:	Learning basic characteristics of sensor systems used in autonomous vehicles.
Code:	1150-MTMTP-ISA-0405_W2
Verification:	Evaluation of the quality of prepared presentation
Connected field of study outcome	K_W15
Outcome:	Learning basic methods of fusion of information coming from many sensor systems.
Code:	1150-MTMTP-ISA-0405_W3
Verification:	Evaluation of the quality of prepared computer program.
Connected field of study outcome	K_W01
Outcome:	Learning possibility to control and perform basic tasks for autonomous vehicles.
Code:	1150-MTMTP-ISA-0405_W4
Verification:	Evaluation of the quality of prepared presentation
Connected field of study outcome	K_W12
Skills	
Outcome:	Ability to apply a chosen algorithm for fusion of information from many sensor systems.
Code:	1150-MTMTP-ISA-0405_U1
Verification:	Evaluation of the quality of prepared solution to a problem performed in the form of homework.
Connected field of study outcome	K_U07, K_U08, K_U10
Outcome:	Ability to apply a chosen algorithm to construct a control system for a non-linear object.
Code:	1150-MTMTP-ISA-0405_U2
Verification:	Evaluation of the quality of prepared solution to a problem performed in the form of homework.
Connected field of study outcome	K_U07, K_U10, K_U22
Outcome:	Ability to apply a chosen algorithm to perform a task of path tracking or

	reaching destination by an autonomous vehicle.
Code:	1150-MTMTP-ISA-0405_U3
Verification:	Evaluation of the quality of prepared solution to a problem performed in the form of homework.
Connected field of study outcome	K_U07, K_U10

Description of a Subject		
SUBJECT: INFORMATION SYSTEMS IN VEHICLES		
Subject code	1150-MTMTP-ISA-0406	
Subject version	Version 1	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program	Vehicle Mechatronics	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the degree program	
Subject group	Connected with the degree program	
Subject level	Advanced	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	VII	
Pre-requisites	Knowledge of power train construction, internal combustion engines, IT systems	
Limit of number of students	Lecture – no limits Laboratory according to University Regulations)(teams of 8 to 12 people)	
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	The aim of the subject is to learn construction, operation and diagnostics of IT systems used in vehicles and their resistance to disturbances, including unauthorized interference.	
Learning outcomes	See **TABLE No 72**	
Form of classes and their duration	Lecture	15 h
	Practicals	
	Laboratory	15 h
	Project	
Learning content	During lectures the following issues will be discussed: kinds of systems used in vehicles, their advantages and disadvantages; detailed presentation of system for data transmission and coding in on-board diagnostic systems and use of network to send data. During laboratory, classes connected with studying CAN network will be conducted, ways of interfering with the network and detecting interferences in controller memory and tools that enable it.	
Evaluation methods	Lecture – Test. Laboratory – evaluation of reports on performed tasks within laboratory exercises, evaluation interview.	
Ways of verifying learning outcomes	See **TABLE No 72**	
Exam	No	

D. Student's contribution	
Number of ECTS points	3
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours - *32,* a) lecture -15 h; b) laboratory- 15. h; c) consultations - 2 h; 2) Studnent's individual work – 43 h, including: a) 25 h –current preparation for exercises, literature study, b) 8 h – preparing for test, c) 10 h – preparing reports. 3) TOTAL –75 hours.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,28 ECTS points – number of contact hours - 32, a) lecture -15 h; b) laboratory- 15. h; c) consultations - 2 h;
Number of ECTS points obtained by a student within practical classes:	1 ECTS point – 25 hours, including: a) laboratoriy- 15 h; b) consultations - 3 h; c) 7 h – preparing reports.
E. Additional information	
Comments	

TABLE No 72. SUBJECT OUTCOMES	
Knowledge	
Outcome:	A student can draw conclusions on condition of vehicle IT systems based on available signals
Code:	1150-MTMTP-ISA-0406_W1
Verification:	Test, evaluation of a report, discussion.
Connected field of study outcome	K_W01, K_W03, K_W05, K_W18, K_W20
Outcome:	Has knowledge on construction and operation principle of mechatronic systems.
Code:	1150-MTMTP-ISA-0406_W2
Verification:	Test, evaluation of a report, discussion.
Connected field of study outcome	K_W09
Outcome:	A student can recognize modification of systems.
Code:	1150-MTMTP-ISA-0406_W3
Verification:	Evaluation of a report
Connected field of study outcome	K_W21
Skills	
Outcome:	A student can effectively use specialist devices.
Code:	1150-MTMTP-ISA-0406_U1
Verification:	Work while performing tasks, evaluation of report, discussion.
Connected field of study outcome	K_U07
Outcome:	Can analyze and identify way of functioning as well as evaluate and formulate conclusions in simple engineering problems.
Code:	1150-MTMTP-ISA-0406_U1
Verification:	Work while performing tasks, evaluation of report, discussion.
Connected field of study outcome e	K_U13, K_U14, K_U15, K_U16, K_U17, K_U18.
Social Competences	

Outcome:	A student can characterize influence of malfunction of particular systems on the environment, including safety of traffic participants and natural environment.
Code:	1150-MTMTP-ISA-0406_K1
Verification:	Test, evaluation of a report, discussion.
Connected field of study outcome	K_K02

Description of a Subject		
SUBJECT: VEHICLE ACOUSTICS		
Subject code	1150-MTMTP-ISA-0407	
Subject version	1	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program	Vehicle Mechatronics	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the degree program	
Subject group	Connected with the degree program	
Subject level	Advanced	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	7	
Pre-requisites	Knowing theory of vibrations, physics of wave motion, machine dynamics, and methods of measuring vibrations and noise, computer methods in mechatronics.	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Learning process of generation, propagation, sound attenuation and standards concerning measuring noise. Ability to perform measurements of vehicle and environmental noise. Awareness of the influence of noise on the environment.	
Learning outcomes	See **TABLE No 73**	
Form of classes and their duration	Lecture	15 h
	Practicals	
	Laboratory	15 h
	Project	
Learning content	**Lecture:** 1. Wave formation within a medium. Acoustic wave equation. Velocity of propagation disturbances. Acoustic potential. 2. Energy description of acoustic field. Subjective noise evaluation. Measurements of acoustic pressure level and sound level. Issues of shaping vibro-acoustic elements and machine systems. 3. Vibrations and sound generation. Contact issues. Sound indicated by friction. Issue of interaction between friction and vibrations. Vibrations and sound in continuous systems considering friction. Vehicle and machine systems as a source of sound generation. 4. Issue of protection against noise. Optimizing parameters of acoustic climate. Noise emission. 5. Standards and research methods: Acoustics – Description and measurements of environmental noise. PN-ISO 1996-3; Automobiles and mopeds. Admissible external noise level. Requirements and research. PN –92/S-04051;	

	Automobiles. Admissible noise level inside a car. Requirements and research. PN –90/S-04052; Station for simulating measurement of internal vehicle noise while driving. Procedure for noise measurement at Vehicle Inspection Station. 6. Vehicle acoustics – traffic noise reduction on the road: sources, propagation track, recipient. Overview of noise reduction methods. 7. Construction solutions in engines reducing noise emission: Applying NVH method (reduction of vibrations and vehicle noise and their components), Electric engines with enlarged range; modifying compressor and engine air intake acoustics; Overview of different types of internal combustion engines and their acoustics. Comparing vibrations and acoustics of standard engines with those of lower capacity. **Laboratory:** Learning in a practical manner about measurement and analysis of vibrations and noise. 1. Measurement of external noise of a vehicle while driving and during stops; 2. Structural measurements of vehicle elements using a 3-D laser Doppler vibrometer; 3. Measuring internal noise of a vehicle while driving and during stops; 4. Measuring engine noise using microphone arrays.
Evaluation methods	**Lecture**: Credit is granted based on a written test and homework. **Laboratory:** Before staring an exercise students' preparation is checked (so called 'entry quiz'). Pass for each exercise is obtained based of properly prepared report in the paper or electronic form, accepted and evaluated by person evaluating given exercise.
Ways of verifying learning outcomes	See **TABLE No 73**
Exam	No
D. Student's contribution	
Number of ECTS points	2
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours - 32 h, including: a) lecture - 15 h; b) laboratory- 15 h; c) consultations - 2 h.; 2) Student's individual work – 18 h, including: a) literature study, doing homework: 5 h; b) preparing for classes: 3 h; c) preparing for test: 5 h.; d) preparing reports: 5 h. 3) TOTAL – 50 h
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,28 ECTS points – number of contact hours - 32 h, including: a) lecture - 15 h; b) laboratory- 15 h; c) consultations - 2 h.
Number of ECTS points obtained by a student within practical classes:	1 ECTS point - 25 hours of student's individual work, including: a) participating in laboratory exercises - 15 hours; b) preparing laboratory report - 5 hours, c) literature study, doing homework: 5 h
E. Additional information	
Comments	

TABLE No 73. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Has knowledge on sound generation, propagation, attenuation processes and standards connected with noise measurements.

Code:	1150-MTMTP-ISA-0407_W1
Verification:	Test, homework
Connected field of study outcome	K_W15, K_W17, K_W18
Outcome:	Knows development trends in modern methods of reducing vehicle noise.
Code:	1150-MTMTP-ISA-0407_W2
Verification:	Test, homework, oral test before admitting to performing exercises, evaluation of reports.
Connected field of study outcome	K_W19, K_W20
Skills	
Outcome:	Can perform measurement of noise and establish its influence on endangering the natural environment.
Code:	1150-MTMTP-ISA-0407_*U1*
Verification:	Oral test before admitting to performing exercises, evaluation of reports.
Connected field of study outcome	K_U08, K_U15, K_U16, K_U17, K_U18, K_U22, K_K02
Social Competences	
Outcome:	Can work individually and in a team
Code:	1150-MTMTP-ISA-0407_*K1*
Verification:	Evaluation of tasks performed while doing exercises, evaluation of report.
Connected field of study outcome	K_K04

Description of a Subject		
SUBJECT: AUTOMATION OF CONSTRUCTION MACHINERY AND EQUIPMENT		
Subject code	1150-MTMR-ISA-0323	
Subject version	Version 1	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program	Mechatronics of Construction Machinery	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with degree program	
Subject group	Connected with degree program	
Subject level	Intermediate	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	6	
Pre-requisites	Basic knowledge in construction machinery design	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Learning methodology of automation of construction machinery.	
Learning outcomes	See **TABLE No 74**	
Form of classes and their duration	Lecture	30 h
	Practicals	-
	Laboratory	15 h
	Project	-

Learning content	**Lecture**. Aims and manifestations of construction machinery and equipment automation. Methodology of construction machinery and equipment automation. Rules for preparing functional models of construction machinery and equipment. Examples of building functional models: digger, loader, bulldozer, grader, scrapper, gantry crane, passenger lift, tower crane, tractor and forklift. Rules for dynamic modelling of construction machinery and equipment. Building digital models of control and supervision systems. Configuring measurement and control tracks. Rules for creating algorithms of digital control. Communication between operator and a machine. Examples of solutions for sample construction machines and equipment. **Laboratory.** Adjusting systems – choice of parameters and frequency characteristics of dynamic systems. Didactic model of manipulator, trajectory, controllers, controller settings. PLC programming. Interface of construction machine operator. Automatic control of pull shovel equipment.
Evaluation methods	**Lecture**: Credit is granted based on a written test and an exam. **Laboratory:** Before staring an exercise students' preparation is checked (so called 'entry quiz'). Pass for each exercise is obtained based of properly prepared report in the paper or electronic form, accepted and evaluated by person evaluating given exercise.
Ways of verifying learning outcomes	See **TABLE No 74**
Exam	Yes
D. Student's contribution	
Number of ECTS points	4
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours - 48*, including* a) lecture – 30 h; b) laboratory – 15 h; c) consultations – 3 h; 2) Student's individual work - 65 hours, including: a) 10 h – current preparation for lecture; b) 10 h – literature study; c) 10 h – preparing for an exam; d) 15 h – preparing for laboratory exercises; e) 20 h – preparing reports. 3) TOTAL – 113 h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,92 ECTS points – number of contact hours - 48, including a) lecture – 30 h; b) laboratory – 15 h; c) consultations – 1 h; d) exam – 2 h;
Number of ECTS points obtained by a student within practical classes:	2 ECTS points – 50 h, including: 1) laboratory exercises – 15 h; 2) 15 h – preparing for laboratory exercises; 3) 20 h – preparing results and reports.
E. Additional information	
Comments	

TABLE No 74 . SUBJECT OUTCOMES	
Knowledge	
Outcome:	Knows the design of construction machinery and equipment and their operation cycles. Knows methodology of automation of construction machinery and equipment and applied mechatronic systems.

Code:	1150-MTMR-ISA-0323_W1
Verification:	Exam, oral test before admitting to performing exercises, evaluation of reports.
Connected field of study outcome	K_W17; K_W18; K_W19; K_W20
Outcome:	Knows rules for building functional models of construction machinery and equipment and systems of operator-machine interface.
Code:	1150-MTMR-ISA-0323_W2
Verification:	Exam, oral test before admitting to performing exercises, evaluation of reports.
Connected field of study outcome	K_W17; K_W18; K_W19; K_W20
Outcome:	Can prepare a set of parameters for automation of operation of a machine and select mechatronic systems for such construction machinery and equipment.
Code:	1150-MTMR-ISA-0323_W3
Verification:	Exam, oral test before admitting to performing exercises, evaluation of reports.
Connected field of study outcome	K_W17; K_W18; K_W19; K_W20
Outcome:	Has knowledge on algorithms for automated machines.
Code:	1150-MTMR-ISA-0323_W4
Verification:	Exam, oral test before admitting to performing exercises, evaluation of reports.
Connected field of study outcome	K_W17; K_W18; K_W19; K_W20
Skills	
Outcome:	Can prepare algorithms for automated construction machinery and equipment and create a sample machine operator interface.
Code:	1150-MTMR-ISA-0323_U1
Verification:	Exam, oral test before admitting to performing exercises, evaluation of report.
Connected field of study outcome	K_U15; K_U16; K_U17; K_U18
Outcome:	Can prepare algorithms for automated construction machinery and equipment and create a sample machine operator interface.
Code:	1150-MTMR-ISA-0323_U2
Verification:	Exam, oral test before admitting to performing exercises, evaluation of reports.
Connected field of study outcome	K_U15; K_U16; K_U17; K_U18
Outcome:	Can choose parameters of measurement tracks for mechatronic systems of chosen machines.
Code:	1150-MTMR-ISA-0323_U3
Verification:	Exam, oral test before admitting to performing exercises, evaluation of reports.
Connected field of study outcome	K_U15; K_U16; K_U17; K_U18
Social Competences	
Outcome:	Can cooperate and work in a group while performing laboratory exercises and preparing report, assuming different roles.
Code:	1150-MTMR-ISA-0323_K1
Verification:	Evaluation of tasks performed while doing exercises, evaluation of report
Connected field of study outcome	K_K04

Description of a Subject	
SUBJECT: CONSTRUCTION MACHINERY	
Subject code	1150-MBMRC-ISA-0323
Subject version	Version I
A. Placing the subject within the study system	

Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program	Mechatronics of Construction Machinery	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the degree program	
Subject group	Connected with the degree program	
Subject level	Intermediate	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	6	
Pre-requisites	Basic knowledge in the field of general mechanics, strength of materials, basics of machine construction (participating in lectures: General Mechanics. Strength of Materials, BMC, Construction Machinery and Equipment).	
Limit of number of students	Laboratory – groups of 7-12 people, Lecture – no limit	
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Learning different kinds of construction machinery, their construction and operation. Gaining the skill to present functional schemes of construction machinery. Knowing development trends in construction machinery.	
Learning outcomes	See **TABLE No 75**	
Form of classes and their duration	Lecture	30 h
	Practicals	-
	Laboratory	15 h
	Project	-
Learning content	**Lecture** 1) Presenting a group of construction machinery and discussing problems related to their influence on ground mediums and rocks. Classification of construction machinery. Production of machines for ground works. Statistical data. 2) Geomaterials as working environment for construction machinery. Physical and mechanical properties of ground and rocks. Laboratory methods of establishing strength of mediums. Methods of establishing strength of mediums within deposits. Analysis of chosen ground and rock mining processes. Methods of establishing mining resistances. 3) Machines for mining and transporting ground masses. Construction details of main systems. Kinematics of construction machinery operation – kinematic schemes of excavators, loaders. Work field of construction machinery. Stability of construction machinery. Determining available and restraining forces in the breakout process. 4) Designing equipment for construction machinery. Basics of design of mechanisms powered by hydraulic cylinders. Powering mechanisms of an excavator (extension arm, arm, bucket). Powering mechanisms of loader, bulldozer, grader, scrapper. 5) Mechanisms of body rotation (construction of mechanisms of body rotation of excavators, the course of rotation process, movement equation, selection of mechanism parameters). 6) Chassis systems of construction machinery. Cooperation between road wheels and tire chassis system with ground medium. Cooperation of caterpillar and caterpillar systems with ground medium. Defining resistances of forces and towing power force. Chassis construction, power train transmission systems. 7) Overview of construction solutions for basic construction machinery:	

	- excavators (single-bucket hydraulic excavators, hydraulic mini-excavators, single-bucker cable excavators, multi-bucket excavators). - traction (caterpillar and wheel) machines for mining and transporting ground masses (graders, crushers, wheel loaders, bulldozers, rippers). - multi-function traction machines (excavator-loaders, excavator-bulldozers). - machines for densifying ground masses - machines for making holes and gaps - machines for paving and regenerating paved surfaces (concrete and asphalt). - materials for crushing construction materials - materials for handling ground mediums, rocks: dump trucks, conveyors (belt, bucket, vibrating). 8) Automation of construction machinery. Operator support systems. Systems monitoring basic operation parameters and equipment location of a machine. Trends in construction machinery development. **Laboratory** • Study of crushing processes in a model jaw crusher. • Cooperation between construction machinery and ground medium. • Excavator - mining process. • Hydraulic cylinders in construction machinery, part 2. • PLC controllers programming. • Vibrating conveyor.
Evaluation methods	**Lecture:** tests. **Laboratory**: Before staring an exercise students' preparation is checked (so called 'entry quiz'). Evaluation of tasks performed while doing exercises, evaluation of reports. **Subject grade** Obtaining a credit is contingent on receiving pass marks both from laboratory (OL), and from lecture (OW). Final grade is a cumulative grade (O). It is calculated in a following manner: O = 0.6*OW + 0.4*OL, **Lecture** Grade for Lecture is established based on two test results. For each test one can obtain from 0 to 20 marks. In order to obtain credit for Lecture, it is necessary to obtain at least 20 effective marks from two tests. Effective points are calculated according to the formula: PE = 2*P-10, where P is the number of points obtained from a test, when P < 10. When P >=10; PE = P. **Laboratory** A pass grade is obtained after passing a short oral/written test, so called "entry quiz", doing exercises correctly, and obtaining at least 3.0 from the report. In order to pass laboratory it is necessary to obtain pass (at least 3.0) from all exercises. Overall grade is an arithmetical average of marks from all the exercises.
Ways of verifying learning outcomes	See **TABLE No 75**
Exam	No
D. Student's contribution	
Number of ECTS points	3
Number of hours of	1) Number of contact hours -48, including:

student's work connected with achieving learning outcomes:	a) lecture - 30 h; b) laboratory - 15 h; c) consultation – 3h; 2) Student's individual work - 27 h, including: a) 9 h – current preparation for lecture and exercises (literature analysis), b) 10 h – preparing reports, c) 8 h – preparing for 2 tests. 3) TOTAL – 90 h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,92 ECTS points – Number of contact hours -48, including: a) lecture - 30 h; b) laboratory – 15 h. c) consultation – 3h;
Number of ECTS points obtained by a student within practical classes:	1,2 ECTS points - 30 h, including: 1) laboratory exercises – 15 h., 2) 5 h – preparing for laboratory exercises, 3) 10 h – preparing results and reports.
E. Additional information	
Comments	

TABLE No 75. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Has knowledge in the field of environment of construction machinery operation. Can determine forces of interaction between machine and ground medium.
Code:	1150-MBMRC-ISA-0323_W1
Verification:	Test, Report on exercise. Short oral/written test verifying student's preparation ('entry quiz').
Connected field of study outcome	K_W_17, K_W_18, K_W_19, K_W_20
Outcome:	Knows different kinds of construction machinery and their role, construction, operation and development trends. Knows construction of main systems of construction machinery and know basics of working equipment design.
Code:	1150-MBMRC-ISA-0323_W2
Verification:	Test
Connected field of study outcome	K_W_17, K_W_18, K_W_19, K_W_20
Skills	
Outcome:	Can draw and discuss functional schemes of construction machinery. Can characterize kinds and basic structure of power train systems of construction machinery.
Code:	1150-MBMRC-ISA-0323_U1
Verification:	Test, Report on exercise. Short oral/written test verifying student's preparation ('entry quiz').
Connected field of study outcome	K_U15, K_U16, K_U17
Outcome:	Knees how to establish and determine operation strains, indISAensable to design construction machinery. Can design kinematics of construction machinery equipment, anticipate construction strains, establish critical spots and formulate appropriate project criteria.
Code:	1150-MBMRC-ISA-0323_U2
Verification:	Test, Report on exercise. Short oral/written test verifying student's preparation ('entry quiz').
Connected field of study outcome	K_U15, K_U16, K_U17, K_U18
Outcome:	Can plan a research experiment and refer its results to theory.
Code:	1150-MBMRC-ISA-0323_U3

Verification:	Report on laboratory exercise
Connected field of study outcome	K_U13
Social Competences	
Outcome:	Can cooperate and work in a group while doing research and preparing report.
Code:	1150-MBMRC-ISA-0323_K1
Verification:	Report on laboratory exercise
Connected field of study outcome	K_K03, K_K04

Description of a Subject		
SUBJECT: PASSENGER LIFTS		
Subject code	1150-MBMRC-ISA-0409	
Subject version	Version I	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program	Mechatronics of Construction Machinery	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the degree program	
Subject group	Connected with the degree program	
Subject level	Intermediate	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	6	
Pre-requisites	No particular pre-requisites. It is advisable to know general mechanics, strength of materials, basics of machine construction (participating in lectures: General Mechanics, Strength of Materials, and BMC).	
Limit of number of students	Laboratory – groups of 7-12 people, lecture- no limit	
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Learning about construction, operation and chosen operation aspects of passenger lifts. Gaining skill of recognizing basic engineering tasks in the field of lift construction and operation. Awareness of effects of engineering activities referring to a group of machines.	
Learning outcomes	See **TABLE No 76**	
Form of classes and their duration	Lecture	30 h
	Practicals	-
	Laboratory	15 h
	Project	-
Learning content	**Lecture** Introduction. Division of means of goods handling means of transport. Definition of a lift. Division of lifts. Lift directive and standards. Location of a lift within a building. Completely housed shafts, panoramic. Spaces in lift shaft (shaft top, shaft bottom). Requirements for shafts, engine room and cable room. Logistic issues. Transport among floors. Lift operation cycle. Course of operation velocity. Choice of working lift parameters and of the number of lifts for a building.	

	Construction and operation of electric lift (friction). Basic kinematic system of friction lifts. Theory of friction feedback. Load capacity coefficient. Forces in load bearing strings. Compensation strings. Static and dynamic states. Lift hoisting winches. Electric engine operation control. Geared and gearless hoisting winches. Construction of hydraulic lift. Hydraulic drive and control system; actuators and valve blocks. Safety systems (grippers, bolts, systems of speed limiters, safety cable, bumpers, pipeline fuses). Cabin inrun into bumpers. Other safety issues. Technical safeguards (conditions of friction feedback, monitoring load, safety coefficients of load bearing strings, bolt release zone, safety connectors, bumpers, monitoring cabin speed (speed limiters), monitoring engine operation time, safety zones, service zones, correlation load bearing capacity – cabin area). Electric powering. Main and administrative power supply. Safeguards. Systems for automatic lift adjustment. Systems for lift control (transposable control, collective, group – collective). Analysis of electric installation of lifts with different controllers. Elements of electromechanical and electronic lift accessories (contractors, relays, limit switches, floor-adjustment switches, stop switches, pulsators, semiconductor elements, logic systems, microprocessor controllers) Lift documentation. Calculation requirements and instructions. Acceptance study. Evaluation of compatibility. Supervising safe lift use – UDT, TDT, WDT. Servicing, periodic examinations, modernizing repairs. **Laboratory** Evaluation of electric lift friction feedback Study of lift string belt system Study of energy intensity of drive system of hydraulic lift Algorithm of system for passenger lift control Study of properties of string systems Dynamics of electric lifts hoisting systems
Evaluation methods	Lecture: tests. Laboratory: Before starting an exercise students' preparation is checked (so called 'entry quiz' – oral/written). Evaluation of tasks performed while doing exercises, evaluation of reports. **Subject grade** Obtaining a credit is contingent on receiving pass marks both from laboratory (OL), and from lecture (OW). Final grade is a cumulative grade (O). It is calculated in a following manner: O = 0.6*OW + 0.4*OL, **Lecture** Grade for Lecture is established based on two test results (for each test one can obtain from 0 to 20 marks) and possibly on other components, the value of which may not exceed 20% of all possible marks. Rules for granting marks for other components are given at the beginning of a semester. In order to obtain credit for the Lecture it is necessary to obtain over half of the required marks. **Laboratory** A pass grade is obtained after passing a short oral/written test, so called "entry quiz", doing exercises correctly, and obtaining at least 3.0 from the report. In order to pass laboratory it is necessary to obtain pass (at least 3.0) from all exercises. Overall grade is an arithmetical average of marks from all the exercises.
Ways of verifying learning outcomes	See **TABLE No 76**
Exam	No

D. Student's contribution	
Number of ECTS points	3
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours -48, including: a) lecture - 30 h; b) laboratory- 15 h. c) consultations – 3h; 2) Student's individual work - 27 h, including a) 3 h – preparing for laboratory exercises, b) 6 h – literature study, c) 8 h – preparing results and reports, d) 10 h – preparing for tests. 3) TOTAL – 75 h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,92 ECTS points – number of contact hours -48, including: a)lecture - 30 h; b)laboratory- 15 h. c)consultations – 3h;
Number of ECTS points obtained by a student within practical classes:	1,28 ECTS points - 32 h, including: 1) 15 h – laboratory exercises, 2) 3 h – preparing for laboratory exercises, 3) 8 h – preparing results and reports, 4) 6 h– literature study.
E. Additional information	
Comments	

TABLE No 76. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Can prepare and perform appropriate measurements in order to diagnose chosen processes of lift operation.
Code:	1150-MBMRC-ISA-0409_W1
Verification:	Test, Report on exercise. Short oral/written test verifying student's preparation ('entry quiz').
Connected field of study outcome	K_W_02, K_W_04, K_W_06, K_W_07, K_W_08, K_W_11, K_W_12, K_W_15, K_W_16, K_W_17, K_W_18.
Skills	
Outcome:	Can identify applied construction solutions and determine the most important aspects of passenger lift operation.
Code:	1150-MBMRC-ISA-0409_U1
Verification:	Test, Report on exercise. Short oral/written test verifying student's preparation ('entry quiz').
Connected field of study outcome	K_U_14
Outcome:	Is aware of effects of lift malfunction and can determine ways of their minimizing at the stage of control system design.
Code:	1150-MBMRC-ISA-0409_U2
Verification:	Test, Report on exercise. Short oral/written test verifying student's preparation ('entry quiz').
Connected field of study outcome	K_U_16, K_U_22,
Outcome:	Knows kinds of drives and lift control systems, their influence on operation and safety of its users.
Code:	1150-MBMRC-ISA-0409_U3
Verification:	Test, Report on exercise. Short oral/written test verifying student's preparation ('entry quiz').

Connected field of study outcome	K_U_15, K_U_23.
Outcome:	Can perform reasoning and analysis indISAensable to design chosen left systems.
Code:	1150-MBMRC-ISA-0409_U4
Verification:	Test
Connected field of study outcome	K_U_07, K_U_08, K_U_09, K_U_10, K_U_11, K_U_16, K_U_17, K_U_18, K_U_19, K_U_20, K_U_21, K_U_24.
Outcome:	Knows safety requirements in lift operation and can apply them in control system design.
Code:	1150-MBMRC-ISA-0409_U5
Verification:	Test, Report on laboratory exercise.
Connected field of study outcome	K_U_14, K_K_02
Social Competences	
Outcome:	Is aware of risks arising from lift operation and realizes formal conditions of lift use.
Code:	1150-MBMRC-ISA-0409_K1
Verification:	Test, Report on laboratory exercise.
Connected field of study outcome	K_K_02

Description of a Subject	
SUBJECT: BASICS OF ELECTRO-MECHANICAL HYBRID DRIVES	
Subject code	1150-00000-ISA-0405
Subject version	Version I
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery
Profile of study	General academic
Degree program	Mechatronics of Construction Machinery
Supervising unit	Faculty of Automotive and Construction Machinery Engineering
Performing unit	Faculty of Automotive and Construction Machinery Engineering
B. General characteristics of the subject	
Subject kind	Connected with the degree program
Subject group	Connected with the degree program
Subject level	Intermediate
Subject status	Compulsory
Language of instruction	English
Nominal semester	VII
Pre-requisites	Knowing basic issues in electrical engineering, presented during lecture Electrical Engineering and Electronics I. Knowing issues presented during lecture Electric power trains. Knowing issues presented during lecture Electronic Systems in Control Systems.
Limit of number of students	
C. Learning outcomes and the manner of conducting classes	
Aim of the subject	Learning basics relating to construction and operation of electro-mechanical, hybrid power trains. Learning basic rules for establishing proper criteria for component selection for hybrid drives. Learning properties and limitations of component use being a part of hybrid power trains, especially primary and secondary energy sources. Learning rules and criteria for power distribution

	control in multi-source power trains.	
Learning outcomes	See **TABLE No 77**	
Form of classes and their duration	Lecture	30 h
	Practicals	-
	Laboratory	-
	Project	-
Learning content	**Lecture** Driving cycle and definition of average power within a cycle. Definitions of primary and secondary energy source. General model of hybrid power train. Hybrid power train operation modes. Recuperation and accumulation of energy. Equation of energy balance for multi-source power train. Primary source power and minimal energy capacity of secondary source. General definition of power summing node and kinds of hybrid power trains. Primary source of energy – internal combustion engine. Properties, limitations and requirements for combustion engine use in hybrid power train. Secondary energy sources – inertial battery and electro-chemical battery. Properties, limitations and requirements for the use of flywheel in hybrid power train. Properties, limitations and requirements for the use of electrochemical battery in hybrid power train. Summing power on electric track – line power train. Power dISAersion in line power train depending on power train operating mode. Summing power on mechanical track – parallel power train. Power dISAersion depending on parallel power train operating mode. Planetary gearbox as power summing node in hybrid power train. Control of power dISAersion in hybrid power train with planetary gearbox with two degrees of freedom.	
Evaluation methods	Credit for **Lecture** is granted based on two tests or students' presentations and discussion.	
Ways of verifying learning outcomes	See **TABLE No 77**	
Exam	No	
D. Student's contribution		
Number of ECTS points	3	
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours - 32, including: a) lecture -30 h.; b) consultations - 2 h; 2) Student's individual work - 43 h, including: a) 23 h – literature study; b) 20 h – preparing for 2 tests, preparing a presentation, 3) TOTAL – 75 h.	
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,28 ECTS point – Number of contact hours - 32, including: a) lecture -30 h.; b) consultations - 2 h;	
Number of ECTS points obtained by a student within practical classes:		
E. Additional information		
Comments		

TABLE No 77. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Has theoretical knowledge and can describe construction and operation of basic power train electromechanical and hybrid structures.

Code:	1150-00000-ISA-0405_ W1
Verification:	Test or evaluation of presentation, discussion
Connected field of study outcome	K_W03, K_W09, K_W12, K_W16, K_W20
Outcome:	Has theoretical knowledge and can establish criteria and limitations in selection of parameters of a hybrid structure from the point of view of applied components.
Code:	1150-00000-ISA-0405_ W2
Verification:	Test or evaluation of presentation, discussion
Connected field of study outcome	K_W03, K_W09, K_W12, K_W16, K_W20
Outcome:	Has theoretical knowledge and can determine criteria for power dISAersion control in hybrid power train, arising from applying structure and components.
Code:	1150-00000-ISA-0405_W3
Verification:	Test or evaluation of presentation, discussion
Connected field of study outcome	K_W03, K_W09, K_W12, K_W13, K_W16, K_W20,
Outcome:	Has theoretical knowledge and can justify the use of a particular kind of secondary and primary energy source in a given structure.
Code:	1150-00000-ISA-0405_ W4
Verification:	Test or evaluation of presentation, discussion
Connected field of study outcome	K_W03, K_W09, K_W12, K_W16, K_W20
Skills	
Outcome:	Knows rules and can choose primary power source and minimal energy capacity of the battery.
Code:	1150-00000-ISA-0405_ U1
Verification:	Test or evaluation of presentation, discussion
Connected field of study outcome	K_U01, K_U16, K_U17.
Outcome:	Can choose a hybrid structure and define power dISAersion typical of this stricture depending on hybrid power train operation mode.
Code:	1150-00000-ISA-0405 _U2
Verification:	Test or evaluation of presentation, discussion
Connected field of study outcome	K_U01, K_U16, K_U17.

Description of a Subject	
SUBJECT: BASICS OF MODELING AND CONTROL OF CONSTRUCTION MACHINERY & EQUIPMENT	
Subject code	1150-00000-ISA-0550
Subject version	Version 1
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery
Profile of study	Connected with the degree program
Degree program	Mechatronics of Construction Machinery
Supervising unit	Faculty of Automotive and Construction Machinery Engineering
Performing unit	Faculty of Automotive and Construction Machinery Engineering
B. General characteristics of the subject	
Subject kind	Connected with the degree program
Subject group	Connected with the degree program
Subject level	Advanced
Subject status	Compulsory

Language of instruction	English	
Nominal semester	6	
Pre-requisites	Basic knowledge in general mechanics, basics of machine construction and vehicle mechanics (participating in lectures: Mechanics, BMC, Vehicles).	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Learning issues related to construction machinery modeling as a stage of design and verification of construction machinery project, and algorithms of control and adjustment. Gaining skill of defining the purpose and creating mathematical and computer models of executive elements of construction machinery, and selection of control and adjustment systems.	
Learning outcomes	See **TABLE No 78**	
Form of classes and their duration	Lecture	15 h
	Practicals	-
	Laboratory	15 h
	Project	-
Learning content	**Lecture**. **1.** Introduction to modelling. Aims and advantages arising from modelling Methods of modelling, modelling and computer simulation tools. 2. Modelling of simple mechanical kinetic, dynamic systems, power train systems, energy flow. 3. Construction machinery control: control methods. 4. Controllers – automatic control systems. 5. Introduction to controllers. 6 Controller modelling. 7. System and controller modeling in Matlab/Simulink environment. **Laboratory:** 1. Computer modelling of executive subsystem operation of machines in Matlab/Simulink environment. 2. Modelling of control and adjustment systems. 3. Synthesis object control. 4. Construction of construction machinery subsystems. • Construction of models of construction machinery subsystems • Construction of computer models of dynamic elements. • Experiment planning, model verification. • Selection of control system elements.	
Evaluation methods	**Lecture**: Credit is granted based on homework – construction of computer model of element of a machine. **Laboratory:** Report on exercises; construction of a model, research, verification.	
Ways of verifying learning outcomes	See **TABLE No 78**	
Exam	No	
D. Student's contribution		
Number of ECTS points	3	
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours - 32, *including* a) lecture -15 h; b) laboratory -15 h; c) consultations – 2 h. 2) Student's individual work - 43 h, including: a) 11 h – current preparation for lecture; b) 12 h – literature study; c) 20 h – preparing results and reports. 3) TOTAL – 75 h.	
Number of ECTS points for	1,28 ECTS points – number of contact hours - 32, *including*	

classes requiring direct participation of members of academic staff:	a) lecture -15 h; b) laboratory -15 h; c) consultations – 2 h.
Number of ECTS points obtained by a student within practical classes:	1,4 ECTS points –35 h, including: 1) laboratory exercises -15 h; 2) 20 h – preparing results and report.
E. Additional information	
Comments	

TABLE No 78. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Has knowledge in the field of systems and dynamic elements and construction of construction machinery, knows operation of basic elements and their dynamic modelling.
Code:	1150-00000-ISA-0550_W1
Verification:	Homework
Connected field of study outcome	K_W17; K_W18; K_W19; K_W20
Outcome:	Has knowledge in the field of adjustment systems and construction of simple controllers.
Code:	1150-00000-ISA-0550_W2
Verification:	Homework
Connected field of study outcome	K_W17; K_W18; K_W19; K_W20
Skills	
Outcome:	Can build computer models of basic dynamic elements.
Code:	1150-00000-ISA-0550_U1
Verification:	Laboratory report.
Connected field of study outcome	K_U15; K_U16; K_U17; K_U18; K_U21
Outcome:	Can identify problems to solve in a robotic problem. Can design movements of robot elements.
Code:	1150-00000-ISA-0550_U2
Verification:	Laboratory report.
Connected field of study outcome	K_U15; K_U16; K_U17; K_U18; K_U21
Social competences	
Outcome:	Can cooperate and work in a group while performing tasks and discussion during laboratory.
Code:	1150-00000-ISA-0550_K1
Verification:	Evaluation of tasks perfumed during class discussions.
Connected field of study outcome	K_K04

Description of a Subject	
SUBJECT: SYSTEMS FOR MONITORING CONSTRUCTION MACHINERY AND EQUIPMENT	
Subject code	1150-MTRMR-ISA-0407
Subject version	Version 1
A. Placing the subject within the study system	
Level of study	I degree

Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program	Mechatronics of Construction Machinery	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	Connected with the degree program	
Subject group	Connected with the degree program	
Subject level	Intermediate	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	7	
Pre-requisites	Basic knowledge in the field of construction machinery automation	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Learning basic rules of HMI system construction.	
Learning outcomes	See **TABLE No 79**	
Form of classes and their duration	Lecture	15 h
	Practicals	-
	Laboratory	15 h
	Project	-
Learning content	**Lecture**. Aims of monitoring automation of machines. Functional models of machines. Examples of building functional models: excavator, loader, bulldozer, crusher, gantry crane, passenger lift, tower and telescopic crane, tractor, forklift. Choice of parameters for monitoring. Choice of mechatronic systems (sensors, on-board computers, operator panels). Ways of building systems (operator – construction machine – environment). Examples of solutions for typical machines (excavator, loader, bulldozer, crane, gantry crane etc.) **Laboratory.** Construction machine operator interface application, Monitoring parameters of hydraulic system, Diagnostics of communication system of machine on-board computer based on CAN network, Monitoring process of working cycle of push shovel.	
Evaluation methods	**Lecture**: credit is granted on the basis of a test. **Laboratory:** Before staring an exercise students' preparation is checked (so called 'entry quiz'). Pass for each exercise is obtained based of properly prepared report in the paper or electronic form, accepted and evaluated by person evaluating given exercise.	
Ways of verifying learning outcomes	See **TABLE No 79**	
Exam	No	
References	1. Automatyzacja pracy maszyn roboczych. Metodyka i zastosowania, Wyd. WKŁ Warszawa 2010. 2. Zaawansowane metody automatyzacji pracy maszyn roboczych, Wyd. ITEE Radom 2013.	
Subject website	_	
D. Student's contribution		
Number of ECTS points	2	
Number of hours of student's work connected with achieving learning	1) Number of contact hours - 32*, including* a) lecture – 15 h; b) laboratory – 15 h;	

outcomes:	c) consultations – 2 h; 2) Student's individual work - 18 h including: a) 2 h – current preparation for lecture; b) 3 h – literature study; c) 5 h – preparing for test, doing homework; d) 3 h – preparing for exercises; e) 5 h – preparing reports. 3) TOTAL –*50* h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,28 ECTS points – number of contact hours - 32*, including* a) lecture – 15 h; b) laboratory – 15 h; c) consultations – 2 h;
Number of ECTS points obtained by a student within practical classes:	0,92 ECTS points– 23 h, including: 1) laboratory exercises – 15 h.; 2) 3 h – preparing for laboratory exercises; 3) 5 h – preparing results and reports.
E. Additional information	
Comments	

TABLE No 79. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Has knowledge in the field of aims and systems for monitoring and automation of machine operation.
Code:	1150-MTRMR-ISA-0407_W1
Verification:	Test, oral test before admitting to exercises, evaluation of reports.
Connected field of study outcome	K_W17; K_W18; K_W19; K_W20
Outcome:	Has knowledge in the field of mechatronic systems selection (sensors, on-board computers, operator panels).
Code:	1150-MTRMR-ISA-0407_W2
Verification:	Test, oral test before admitting to exercises, evaluation of reports.
Connected field of study outcome	K_W17; K_W18; K_W19; K_W20
Outcome:	Has knowledge in the field of constructing HMI systems (operator – construction machine – environment).
Code:	1150-MTRMR-ISA-0407_W3
Verification:	Test, oral test before admitting to exercises, evaluation of reports.
Connected field of study outcome	K_W17; K_W18; K_W19; K_W20
Outcome:	Has knowledge in the field of choice of monitoring parameters for: excavator, loader, bulldozer, grader, gantry crane, passenger lift, tower and telescopic crane, tractor and forklift.
Code:	1150-MTRMR-ISA-0407_W4
Verification:	Test, oral test before admitting to exercises, evaluation of reports.
Connected field of study outcome	K_W17; K_W18; K_W19; K_W20
Skills	
Outcome:	Knows ways and methods of building HMI systems (operator – construction machine – environment).
Code:	1150-MTRMR-ISA-0407_U1
Verification:	Test, oral test before admitting to exercises, evaluation of reports.
Connected field of study outcome	K_U15; K_U16; K_U17; K_U18
Outcome:	Can choose parameters for monitoring, choose mechatronic systems sensors, on-

	board computers, operator panels for typical machines (excavator, loader, bulldozer, grader, gantry crane, passenger lift, tower and telescopic crane, tractor and forklift etc.).
Code:	1150-MTRMR-ISA-0407_U2
Verification:	Test, oral test before admitting to exercises, evaluation of reports.
Connected field of study outcome	K_U15; K_U16; K_U17; K_U18
Outcome:	Can design and build monitoring system for a chosen machine.
Code:	1150-MTRMR-ISA-0407_U3
Verification:	Test, oral test before admitting to exercises, evaluation of reports.
Connected field of study outcome	K_U15; K_U16; K_U17; K_U18, K_U20.
Social Competences	
Outcome:	Can cooperate and work in a group while performing laboratory exercises and preparing report, assuming different roles..
Code:	K1
Verification:	Evaluation of tasks performed while doing exercises, evaluation of report.
Connected field of study outcome	K_K04

Description of a Subject	
SUBJECT: FOREIGN LANGUAGE 1	
1	JO1
Subject version	Version 1
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery
Profile of study	General academic
Degree program	
Supervising unit	Foreign Language Center (SJO PW)
Performing unit	Foreign Language Center (SJO PW)
B. General characteristics of the subject	
Subject kind	General
Subject group	Foreign Languages
Subject level	(according to Common European Framework of Reference for Languages) B1- B2 – before B2 exam A1-C2- after B2 exam, different languages from SJO PE offer
Subject status	Compulsory
Language of instruction	Foreign language selected by a student from SJO PW offer
Nominal semester	3
Pre-requisites	Before B2 exam – not lover than A2 level Can understand sentences and frequently used expressions related to areas of most immediate relevance. Can communicate in simple and routine tasks requiring a simple and direct exchange of information on familiar and routine matters. Can describe in simple terms aspects of his/her background, immediate environment and matters in areas of immediate need. Recommended B1 lever or higher Can understand the main points of clear standard input on familiar matters regularly encountered in work, school, leisure, etc. Can deal with most situations likely to arise whilst travelling in an area where the language is spoken. Can produce simple connected text on topics which are familiar or of

	personal interest. Can describe experiences and events, dreams, hopes & ambitions and briefly give reasons and explanations for opinions and plans.	
Limit of number of students	Minimum number of students 12 maximum number of students 24	
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Achieving B2 level according to Common European Framework of Reference for Languages, within the scope of general language, with elements of specialized vocabulary necessary for a graduate of a technical University, varying depending on the Field of Study.	
Learning outcomes	See **TABLE No 84**	
Form of classes and their duration	Lecture	
	Practicals	60 h
	Laboratory	
	Project	
Learning content	Sample learning content for English: Lexical material: vocabulary connected with topics such as: personality, travel, work. Personality adjectives, prefixes, expressions and adjectives connected with travel, work and time. Vocabulary connected with learning foreign languages, advertising, and business. Phrasal verbs. Verb patterns with: allow, permit, let, and expressing permission. Collocations. Expressions for making presentations. Grammar material: tenses: Past Simple, Present Perfect Simple, Present Perfect Continuous; regular and irregular verbs. Ways of expressing future - Future Simple, to be going to, Present Continuous. I and II type conditional sentences. Comparison of adjectives. Language skills: developing speaking, reading and listening comprehension related to lexical material. Writing notes, essays, biographic notes and cover letter, developing speaking, reading and listening comprehension, writing a report, leaflet, formal and informal email.	
Evaluation methods	Short tests. Discussions. Presentation. Homework. Written assignments. Module tests.	
Ways of verifying learning outcomes	See **TABLE No 84**	
Exam	No	
D. Student's contribution		
Number of ECTS points	4	
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours – 63, including: a) participating in practicals – 60 h. b) consultations – 3 h. 2) Student's individual work – 60 h, including: a) current preparation for classes, doing homework – 30 h, b) preparing for tests – 20 h. c) preparing for final test – 10h.	
Number of ECTS points for classes requiring direct participation of members of academic staff:	2,52 ECTS points - number of contact hours – 63, including: a) participating in practicals – 60 h. b) consultations – 3 h.	
Number of ECTS points obtained by a student within practical classes:	4	

E. Additional information	
Comments	The time needed to achieve B2 level depends on initial level: A2, B1 or B2.

TABLE No 84. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Has a well-ordered knowledge of grammar structures and vocabulary related to understanding and creating different kinds of written and spoken texts, both formal and informal, general and specialized.
Code:	JO1_W1
Verification:	Short tests. Discussions. Presentation. Homework. Written assignments. Module tests.
Connected field of study outcome	K_W21.
Skills	
Outcome:	Can create different kinds of texts – for personal and professional use (e.g. cover letter, resume, report, note, essay) and apply grammar and stylistic forms required at B2 level – personal and professional. Can read and understand general and specialized text, related to their domain, obtain and interpret information. Can express themselves and have a conversation connected with general and specialized topic in a clear, spontaneous, fluent and understandable manner, using grammar and stylistic forms required at B2 level as well as can prepare an oral presentation, relating to detailed issues within the chosen Field of Study.
Code:	JO1_U1
Verification:	Short tests. Discussions. Presentation. Homework. Written assignments. Module tests.
Connected field of study outcome	K_U05, K_U01
Social competences	
Outcome:	Can work individually and in a group.
Code:	JO1_K1
Verification:	Short tests. Discussions. Presentation. Homework. Written assignments. Module tests.
Connected field of study outcome	K_K04

Description of a Subject	
SUBJECT: FOREIGN LANGUAGE 2	
1	JO2

Subject version	Version 1	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program		
Supervising unit	Foreign Language Center (SJO PW)	
Performing unit	Foreign Language Center (SJO PW)	
B. General characteristics of the subject		
Subject kind	General	
Subject group	Foreign Languages	
Subject level	(according to Common European Framework of Reference for Languages) B1- B2 – before B2 exam A1-C2- after B2 exam, different languages from SJO PE offer	
Subject status	Compulsory	
Language of instruction	Foreign language selected by a student from SJO PW offer	
Nominal semester	4	
Pre-requisites	<u>Before B2 exam – not lover than A2 level</u> Can understand sentences and frequently used expressions related to areas of most immediate relevance. Can communicate in simple and routine tasks requiring a simple and direct exchange of information on familiar and routine matters. Can describe in simple terms aspects of his/her background, immediate environment and matters in areas of immediate need. <u>Recommended B1 lever or higher</u> Can understand the main points of clear standard input on familiar matters regularly encountered in work, school, leisure, etc. Can deal with most situations likely to arise whilst travelling in an area where the language is spoken. Can produce simple connected text on topics which are familiar or of personal interest. Can describe experiences and events, dreams, hopes & ambitions and briefly give reasons and explanations for opinions and plans.	
Limit of number of students	Minimum number of students 12 maximum number of students 24	
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Achieving B2 level according to Common European Framework of Reference for Languages, within the scope of general language, with elements of specialized vocabulary necessary for a graduate of a technical University, varying depending on the Field of Study.	
Learning outcomes	See **TABLE No 84**	
Form of classes and their duration	Lecture	
	Practicals	60 h
	Laboratory	
	Project	
Learning content	Sample learning content for English: Lexical material: vocabulary connected with topics such as: personality, travel, work. Personality adjectives, prefixes, expressions and adjectives connected with travel, work and time. Vocabulary connected with learning foreign languages, advertising, and business. Phrasal verbs. Verb patterns with: allow, permit, let, and expressing permission. Collocations. Expressions for making presentations. Grammar material: tenses: Past Simple, Present Perfect Simple, Present Perfect Continuous; regular and irregular verbs. Ways of expressing future - Future Simple, to be going to, Present Continuous. I and II type conditional sentences. Comparison of adjectives.	

	Language skills: developing speaking, reading and listening comprehension related to lexical material. Writing notes, essays, biographic notes and cover letter, developing speaking, reading and listening comprehension, writing a report, leaflet, formal and informal email.
Evaluation methods	Short tests. Discussions. Presentation. Homework. Written assignments. Module tests.
Ways of verifying learning outcomes	See **TABLE No 84**
Exam	No
D. Student's contribution	
Number of ECTS points	4
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours – 63, including: a) participating in practicals – 60 h. b) consultations – 3 h. 2) Student's individual work – 60 h, including: a) current preparation for classes, doing homework – 30 h, b) preparing for tests – 20 h. c) preparing for final test – 10h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	2,52 ECTS points - number of contact hours – 63, including: a) participating in practicals – 60 h. b) consultations – 3 h.
Number of ECTS points obtained by a student within practical classes:	4
E. Additional information	
Comments	The time needed to achieve B2 level depends on initial level: A2, B1 or B2.

TABLE No 85. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Has a well-ordered knowledge of grammar structures and vocabulary related to understanding and creating different kinds of written and spoken texts, both formal and informal, general and specialized.
Code:	JO2_W1
Verification:	Short tests. Discussions. Presentation. Homework. Written assignments. Module tests.
Connected field of study outcome	K_W21.
Skills	
Outcome:	Can create different kinds of texts – for personal and professional use (e.g. cover letter, resume, report, note, essay) and apply grammar and stylistic forms required at B2 level – personal and professional. Can read and understand general and specialized text, related to their domain, obtain and interpret information.

	Can express themselves and have a conversation connected with general and specialized topic in a clear, spontaneous, fluent and understandable manner, using grammar and stylistic forms required at B2 level as well as can prepare an oral presentation, relating to detailed issues within the chosen Field of Study.
Code:	JO2_U1
Verification:	Short tests. Discussions. Presentation. Homework. Written assignments. Module tests.
Connected field of study outcome	K_U05, K_U01
Social competences	
Outcome:	Can work individually and in a group.
Code:	JO2_K1
Verification:	Short tests. Discussions. Presentation. Homework. Written assignments. Module tests.
Connected field of study outcome	K_K04

Description of a Subject	
SUBJECT: FOREIGN LANGUAGE 3	
1	JO3
Subject version	Version 1
A. Placing the subject within the study system	
Level of study	I degree
Form of study	Full-time study
Field of study	Mechatronics of Vehicles and Construction Machinery
Profile of study	General academic
Degree program	
Supervising unit	Foreign Language Center (SJO PW)
Performing unit	Foreign Language Center (SJO PW)
Subject coordinator	Teachers of Foreign Language Center
B. General characteristics of the subject	
Subject kind	General
Subject group	Foreign Languages
Subject level	(according to Common European Framework of Reference for Languages) B1- B2 – before B2 exam A1-C2- after B2 exam, different languages from SJO PE offer
Subject status	Compulsory
Language of instruction	Foreign language selected by a student from SJO PW offer
Nominal semester	5
Pre-requisites	<u>Before B2 exam – not lover than A2 level</u> Can understand sentences and frequently used expressions related to areas of most immediate relevance. Can communicate in simple and routine tasks requiring a simple and direct exchange of information on familiar and routine matters. Can describe in simple terms aspects of his/her background,

	immediate environment and matters in areas of immediate need. Recommended B1 lever or higher Can understand the main points of clear standard input on familiar matters regularly encountered in work, school, leisure, etc. Can deal with most situations likely to arise whilst travelling in an area where the language is spoken. Can produce simple connected text on topics which are familiar or of personal interest. Can describe experiences and events, dreams, hopes & ambitions and briefly give reasons and explanations for opinions and plans.	
Limit of number of students	Minimum number of students 12 maximum number of students 24	
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Achieving B2 level according to Common European Framework of Reference for Languages, within the scope of general language, with elements of specialized vocabulary necessary for a graduate of a technical University, varying depending on the Field of Study.	
Learning outcomes	See **TABLE No 84**	
Form of classes and their duration	Lecture	
	Practicals	60 h
	Laboratory	
	Project	
Learning content	Sample learning content for English: Lexical material: vocabulary connected with topics such as: personality, travel, work. Personality adjectives, prefixes, expressions and adjectives connected with travel, work and time. Vocabulary connected with learning foreign languages, advertising, and business. Phrasal verbs. Verb patterns with: allow, permit, let, and expressing permission. Collocations. Expressions for making presentations. Grammar material: tenses: Past Simple, Present Perfect Simple, Present Perfect Continuous; regular and irregular verbs. Ways of expressing future - Future Simple, to be going to, Present Continuous. I and II type conditional sentences. Comparison of adjectives. Language skills: developing speaking, reading and listening comprehension related to lexical material. Writing notes, essays, biographic notes and cover letter, developing speaking, reading and listening comprehension, writing a report, leaflet, formal and informal email.	
Evaluation methods	Short tests. Discussions. Presentation. Homework. Written assignments. Module tests.	
Ways of verifying learning outcomes	See **TABLE No 84**	
Exam	No	
References	Textbooks according to syllabus + teacher's own materials	
Subject website	WWW.sjo.pw.edu.pl	
D. Student's contribution		
Number of ECTS points	4	
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours – 63, including: a) participating in practicals – 60 h. b) consultations – 3 h. 2) Student's individual work – 60 h, including: a) current preparation for classes, doing homework – 30 h,	

	b) preparing for tests – 20 h. c) preparing for final test – 10h.
Number of ECTS points for classes requiring direct participation of members of academic staff:	2,52 ECTS points - number of contact hours – 63, including: a) participating in practicals – 60 h. b) consultations – 3 h.
Number of ECTS points obtained by a student within practical classes:	4
E. Additional information	
Comments	The time needed to achieve B2 level depends on initial level: A2, B1 or B2.

TABLE No 86. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Has a well-ordered knowledge of grammar structures and vocabulary related to understanding and creating different kinds of written and spoken texts, both formal and informal, general and specialized.
Code:	JO3_W1
Verification:	Short tests. Discussions. Presentation. Homework. Written assignments. Module tests.
Connected field of study outcome	K_W21.
Skills	
Outcome:	Can create different kinds of texts – for personal and professional use (e.g. cover letter, resume, report, note, and essay) and apply grammar and stylistic forms required at B2 level – personal and professional. Can read and understand general and specialized text, related to their domain, obtain and interpret information. Can express themselves and have a conversation connected with general and specialized topic in a clear, spontaneous, fluent and understandable manner, using grammar and stylistic forms required at B2 level as well as can prepare an oral presentation, relating to detailed issues within the chosen Field of Study.
Code:	JO3_U1
Verification:	Short tests. Discussions. Presentation. Homework. Written assignments. Module tests.
Connected field of study outcome	K_U05, K_U01
Social competences	
Outcome:	Can work individually and in a group.
Code:	JO3_K1
Verification:	Short tests. Discussions. Presentation. Homework.

	Written assignments. Module tests.
Connected field of study outcome	K_K04

Description of a Subject		
SUBJECT: HISTORY OF TECHNOLOGY		
Subject code	1150-00000-ISA-0111	
Subject version	Version I	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	General	
Subject group	HES	
Subject level	Basic	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	I	
Pre-requisites	-	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	The purpose of the course is to acquaint participants with basic facts in the history of technology of the last three centuries. The course begins with a short introduction into the methodology of history of technology, than lectures are devoted to the development of heat engines and communication. The last lecture describes the rise of the automotive industry in the first half of the 20th century.	
Learning outcomes	See **TABLE No 87**	
Form of classes and their duration	Lecture	15 h
	Practicals	
	Laboratory	
	Project	
Learning content	1. History of technology: Basic definitions 2. The supply of energy before and after the Industrial Revolution 3. James Watt, or pros and cons of the Age of Steam 4. George Stephenson and the development of the railways 5. The twilight of the age Age of Sail and the development of steam propelled ships. 6. From guns to motor vehicles: the American System of Manufacture. 7. All highways lead to Rome, or a short history of roadbuilding. 8. Ford vs. Sloan or the birth of automotive industry.	
Evaluation methods	Homework: each student Has to summarize two scientific articles devoted to history of technology; Final test to verify the knowledge.	
Ways of verifying learning outcomes	See **TABLE No 87**	
Exam	No	
D. Student's contribution		

Number of ECTS points	1
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours – 16 h, including: a) lecture -15 h; b) consultations - 1 h; 2) Student's individual work -10 h, including: a) 8 h – literature study b) 2 h – preparation for test 3) TOTAL – 26 h
Number of ECTS points for classes requiring direct participation of members of academic staff:	0,64 ECTS point – number of contact hours – 16 h, including: a) lecture -15 h; b) consultations - 1 h;
Number of ECTS points obtained by a student within practical classes:	
E. Additional information	
Comments	

TABLE No 87. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Has basic knowledge in development trends in terms of means of transport.
Code:	1150-00000-ISA-0111_W1
Verification:	Test.
Connected field of study outcome	K_W14
Outcome:	Has general knowledge which enables to understand social, economic, legal and other non-technical aspects of means of transport development.
Code:	1150-00000-ISA-0111_W2
Verification:	Test.
Connected field of study outcome	K_W21
Skills	
Outcome:	Can evaluate technical solutions in vehicles and their influence on safety and environment, considering historical aspects.
Code:	1150-00000-ISA-0111_U1
Verification:	Test.
Connected field of study outcome	K_U22, K_U09
Social Competences	
Outcome:	Is aware of the importance and understands non-technical aspects and effects of mechanical engineer's activity, including the influence of this activity on environment and safety of transport.
Code:	1150-00000-ISA-0111_K1
Verification:	Test
Connected field of study outcome	K_K02

Description of a Subject	
SUBJECT: ECONOMY	
Subject code	1180-MT000-ISA-0401
Subject version	Version 1

A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	General	
Subject group	HES	
Subject level	Basic	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	7	
Pre-requisites	-	
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Understanding market economy. Learning basic economical categories and mechanisms. Learning to interpret and evaluate socio-economical phenomena.	
Learning outcomes	See **TABLE No 88**	
Form of classes and their duration	Lecture	30
	Practicals	
	Laboratory	
	Project	
Learning content	Object and scope of economy. Resources vs. human needs. Basic economic categories: supply, demand, elasticity of supply and demand. Phenomenon of competition, market structures in economy. Income, revenue, business costs. Production factors market. Capital market. Unemployment and inflation. Role of economic growth and development. Role of state in economy. Economic integration.	
Evaluation methods	Written test	
Ways of verifying learning outcomes	See **TABLE No 88**	
Exam	No	
D. Student's contribution		
Number of ECTS points	2	
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours – 32,including: a) lecture - 30 h; b) consultations - 2 h; 2) Student's individual work - literature study, preparing for test 18 h. 3) TOTAL – 50 h.	
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,28 ECTS points - number of contact hours – 32,including: a) lecture - 30 h; b) consultations - 2 h;	
Number of ECTS points obtained by a student within practical classes:	-	
E. Additional information		
Comments		

TABLE No 88. SUBJECT OUTCOMES	
Knowledge	
Outcome:	Knows rules for creating and development of individual entrepreneurship.
Code:	*1180-MT000-ISA-0401_W1*
Verification:	Test
Connected field of study outcome	K_W24
Skills	
Outcome:	A student can interpret socio-economic phenomena based on performed literature analysis.
Code:	1180-MT000-ISA-0401_U1
Verification:	Test
Connected field of study outcome	K_U01, K_U06.

Description of a Subject		
SUBJECT: INTELLECTUAL PROPERTY		
Subject code	1150-00000-ISA-0112	
Subject version	Version I	
A. Placing the subject within the study system		
Level of study	I degree	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program		
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	General	
Subject group	HES	
Subject level	Basic	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	I	
Pre-requisites		
Limit of number of students		
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Gaining knowledge about intellectual property law and industrial property law in particular. Gaining knowledge about ways of protection of intellectual property. Preliminary classification of solutions or creations as particular intellectual property goods. Basic competence in protecting particular intellectual property and avoidance of its premature disclosure. Ability to use citations properly and prepare texts based on academic literature. The student is aware of the need to adhere to professional ethics and legal regulations, in particular in the field of intellectual property.	
Learning outcomes	See **TABLE No 89**	
Form of classes and their duration	Lecture	15 h
	Practicals	-
	Laboratory	-

	Project	-
Learning content	Lecture: 1. Introduction to intellectual property law: term, scope, origin. Lecture: 2. Copyright: object, term, categories of pieces. Lecture: 3. Personal copyright, assets and copyright protection. Lecture: 4. Notion and object of related laws. Lecture: 5. Notion of invention and patent ability. Patent handling, licenses.	
Evaluation methods	Students mark the answers they consider correct. Then the teacher checks, whether the answers are in fact correct and grants a point for each correct answer. If a student reaches 70% of available points – they pass the test with a 3. Higher grades are awarded for higher numbers of points.	
Ways of verifying learning outcomes	See **TABLE No 89**	
Exam	No	
D. Student's contribution		
Number of ECTS points	1	
Number of hours of student's work connected with achieving learning outcomes:	1) Number of contact hours – 16, including: a) lecture -15 h; b) consultations - 1 h. 2) Student's individual work – 9 h, including: a) 6 h. – literature study, b) 3 h – preparing for 1 test . 3) RAZEM – 25 h.	
Number of ECTS points for classes requiring direct participation of members of academic staff:	0,64 ECTS point – number of contact hours – 16, including: a) lecture -15 h; b) consultations - 1 h.	
Number of ECTS points obtained by a student within practical classes:		
E. Additional information		
Comments		

TABLE No 89. SUBJECT OUTCOMES	
Knowledge	
Outcome:	A student can explain basic terms (piece and its kinds, assets copyright, personal copyright, plagiarism and its kinds and examples, invention, patent) and can enumerate the most important Acts of intellectual property law.
Code:	1150-00000-ISA-0112_W1
Verification:	Test
Connected field of study outcome	K_W22
Social Competences	
Outcome:	A student is aware how to use information sources not to commit plagiarism e.g. while writing diploma dissertation.
Code:	1150-00000-ISA-0112_K1
Verification:	Discussion during classes
Connected field of study outcome	K_03

Description of a Subject

HUMANITIES/ENONOMY SUBJECT (HES)

Subject code	HES3	
Subject	Humanities/Economy Subject 3	
Subject version		
A. Placing the subject within the study system		
Level of study	I degree studies	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program	-	
Supervising unit	Faculty of Automotive and Construction Machinery Engineering	
Performing unit	Faculty of Automotive and Construction Machinery Engineering	
B. General characteristics of the subject		
Subject kind	General	
Subject group	HES	
Subject status	Compulsory	
Language of instruction	English	
Nominal semester	7	
Nominal semester	Winter	
Pre-requisites	-	
Limit of number of students	150	
C. Learning outcomes and the manner of conducting classes		
Aim of the subject	Detailed aim of the subject is given in the Subject Sheet for each of the available classes	
Learning outcomes	Detailed learning outcomes are given in the Subject Sheet for each of the available classes	
Form of classes and their duration	Lecture	30
	Practicals	0
	Laboratory	0
	Project	0
Learning content	Detailed learning content is given in the Subject Sheet for each of the available classes	
Evaluation methods	Detailed evaluation methods are given in the Subject Sheet for each of the available classes	
Ways of verifying learning outcomes	Detailed ways of verifying learning outcomes are given in the Subject Sheet for each of the available classes	
Exam	No	
D. Student's contribution		
Number of ECTS points	2	
Number of hours of student's work connected with achieving learning outcomes:	About 50 hours: Tutorials - 30 hours Individual work, preparation for test- 18 hours. Consultations - 2 h.	
Number of ECTS points for classes requiring direct participation of members of academic staff:	1,28 (about 32 hours) - Detailed information is given in the Subject Sheet for each of the available classes	
Number of ECTS points obtained by a student within practical classes:	Detailed information is given in the Subject Sheet for each of the available classes	
E. Additional information		
Comments	Detailed learning depend on the subject and are given in the Subject Sheet for each of the available classes.	

Description of a Subject		
PHYSICAL EDUCATION 1		
Subject code	WF1	
Subject	Physical Education 1	
Subject version		
A. PLACING THE SUBJECT WITHIN THE STUDY SYSTEM		
Level of study	I degree study	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program	-	
Supervising unit	Faculty of Automotive and Construction Machinery	
Performing unit	Studium Wychowania Fizycznego i Sportu	
B. GENERAL CHARACTERISTICS OF THE SUBJECT		
Subject kind	General	
Subject group	Physical Education	
Subject status	Compulsory	
Language of classes	Polish	
Nominal semester	2	
Placing the subject execution within academic year		
Pre-requisites	-	
Limit of number of students		
C. LEARNING OUTCOMES AND THE MANNER OF CONDUCTING CLASSES		
Aim of the subject	Developing students' fitness and their concern to keep fit.	
Learning outcomes	Developing students' fitness and their concern to keep fit.	
Form of classes and their duration	Lecture	
	Practicals	30
	Laboratory	0
	Project	0
Learning content	Detailed learning content is given in the Subject Sheet for each of the available classes	
Evaluation methods	Practical classes according to the offer of Studium Wychowania Fizycznego i Sportu	
Ways of verifying learning outcomes	According to SWFiS Regulations	
Exam	No	
References	References are given by a teacher from the SWFiS list for students of the University	
Subject website		
D. STUDENT'S CONTRIBUTION		
Number of ECTS points	0	
Number of hours student's work connected with achieving learning outcomes:	Taking part in practical classes offered by SWFiS-30 hours	
Number of ECTS points for classes requiring direct participation of members of academic Staff:		
Number of ECTS points obtained by a student within practical classes:		

E. ADDITIONAL INFORMATION	
Comments	

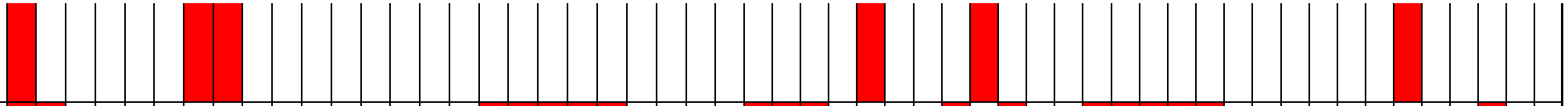
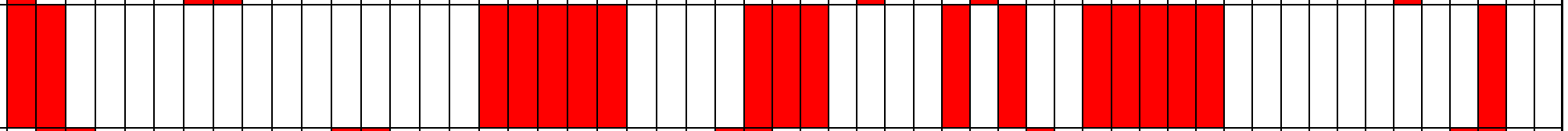
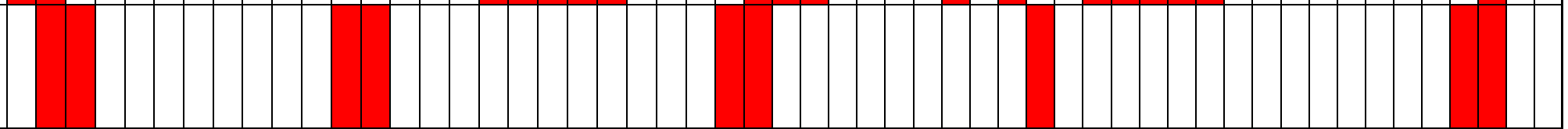
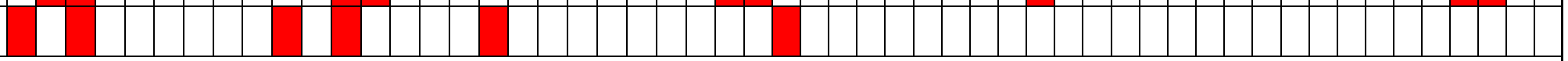
Description of a Subject		
PHYSICAL EDUCATION 2		
Subject code	WF2	
Subject	Physical Education 2	
Subject version		
A. PLACING THE SUBJECT WITHIN THE STUDY SYSTEM		
Level of study	I degree study	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program	-	
Supervising unit	Faculty of Automotive and Construction Machinery	
Performing unit	Studium Wychowania Fizycznego i Sportu	
Subject coordinator	A teacher authorized by Studium Wychowania Fizycznego i Sportu to coordinate cooperation with the Faculty	
B. GENERAL CHARACTERISTICS OF THE SUBJECT		
Subject kind	General	
Subject group	Physical Education	
Subject status	Compulsory	
Language of classes	Polish	
Nominal semester	3	
Placing the subject execution within academic year		
Pre-requisites	-	
Limit of number of students		
C. LEARNING OUTCOMES AND THE MANNER OF CONDUCTING CLASSES		
Aim of the subject	Developing students' fitness and their concern to keep fit.	
Learning outcomes	Developing students' fitness and their concern to keep fit.	
Form of classes and their duration	Lecture	
	Practicals	30
	Laboratory	0
	Project	0
Learning content	Detailed learning content is given in the Subject Sheet for each of the available classes	
Evaluation methods	Practical classes according to the offer of Studium Wychowania Fizycznego i Sportu	
Ways of verifying learning outcomes	According to SWFiS Regulations	
Exam	No	
References	References are given by a teacher from the SWFiS list for students of the University	
Subject website		
D. STUDENT'S CONTRIBUTION		
Number of ECTS points	0	
Number of hours student's work connected with achieving learning outcomes:	Taking part in practical classes offered by SWFiS- 30 hours	

Number of ECTS points for classes requiring direct participation of members of academic Staff:	
Number of ECTS points obtained by a student within practical classes:	
E. ADDITIONAL INFORMATION	
Comments	

Description of a Subject		
PHYSICAL EDUCATION 3		
Subject code	WF3	
Subject	Physical Education 3	
Subject version		
A. PLACING THE SUBJECT WITHIN THE STUDY SYSTEM		
Level of study	I degree study	
Form of study	Full-time study	
Field of study	Mechatronics of Vehicles and Construction Machinery	
Profile of study	General academic	
Degree program	-	
Supervising unit	Faculty of Automotive and Construction Machinery	
Performing unit	Studium Wychowania Fizycznego i Sportu	
Subject coordinator	A teacher authorized by Studium Wychowania Fizycznego i Sportu to coordinate cooperation with the Faculty	
B. GENERAL CHARACTERISTICS OF THE SUBJECT		
Subject kind	General	
Subject group	Physical Education	
Subject status	Compulsory	
Language of classes	Polish	
Nominal semester	4	
Placing the subject execution within academic year		
Pre-requisites	-	
Limit of number of students		
C. LEARNING OUTCOMES AND THE MANNER OF CONDUCTING CLASSES		
Aim of the subject	Developing students' fitness and their concern to keep fit.	
Learning outcomes	Developing students' fitness and their concern to keep fit.	
Form of classes and their duration	Lecture	
	Practicals	30
	Laboratory	0
	Project	0
Learning content	Detailed learning content is given in the Subject Sheet for each of the available classes	
Evaluation methods	Practical classes according to the offer of Studium Wychowania Fizycznego i Sportu	
Ways of verifying learning outcomes	According to SWFiS Regulations	
Exam	No	
References	References are given by a teacher from the SWFiS list for students of the University	
Subject website		

D. STUDENT'S CONTRIBUTION	
Number of ECTS points	0
Number of hours student's work connected with achieving learning outcomes:	Taking part in practical classes offered by SWFiS- 30 hours
Number of ECTS points for classes requiring direct participation of members of academic Staff:	
Number of ECTS points obtained by a student within practical classes:	
E. ADDITIONAL INFORMATION	
Comments	

Nazwa	Wiedza																								Umiejętności																									Kompetencje społeczne					
	K_W01	K_W02	K_W03	K_W04	K_W05	K_W06	K_W07	K_W08	K_W09	K_W10	K_W11	K_W12	K_W13	K_W14	K_W15	K_W16	K_W17	K_W18	K_W19	K_W20	K_W21	K_W22	K_W23	K_W24	K_U01	K_U02	K_U03	K_U04	K_U05	K_U06	K_U07	K_U08	K_U09	K_U10	K_U11	K_U12	K_U13	K_U14	K_U15	K_U16	K_U17	K_U18	K_U19	K_U20	K_U21	K_U22	K_U23	K_U24	K_K01	K_K02	K_K03	K_K04	K_K05	K_K06
IV.1.1. PRZEDMIOTY PODSTAWOWE																																																						
ANALYSIS I	■		■																						■																									■					
ALGEBRA I	■																								■																														
ANALYSIS II	■		■																						■		■																								■					
DIFFERENTIAL EQUATIONS	■	■	■																						■																														
CHEMISTRY		■																								■																														
PHYSICS I		■	■																						■																														
PHYSICS II		■	■																						■																														
THEORETICAL MECHANICS I	■		■																						■		■																								■					
THEORETICAL MECHANICS II	■		■																						■		■																								■					
FLUID MECHANICS	■		■													■																									■										■					
LABORATORY OF FLUID MECHANICS			■																							■										■	■													■			■	■	
PHYSICS III	■	■	■																						■					■																									
STRUCTURAL MATERIALS					■																				■																														
STRUCTURAL MATERIALS LABORATORY					■										■					■							■	■								■																■				
STRENGTH OF MATERIALS I	■		■	■	■	■																							■	■																								
COMPUTER TECHNIQUES I	■						■	■																									■																				■				

INTRODUCTION TO SOFTWARE ENGINEERING	
ELECTRICAL AND ELECTRONICS ENGINEERING I	
ELECTRICAL AND ELECTRONICS ENGINEERING II	
THERMODYNAMICS	
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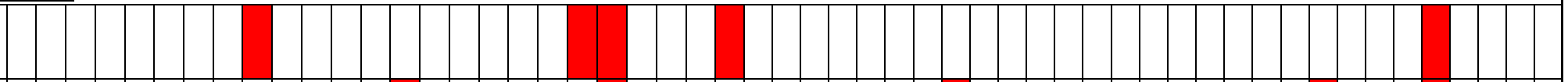
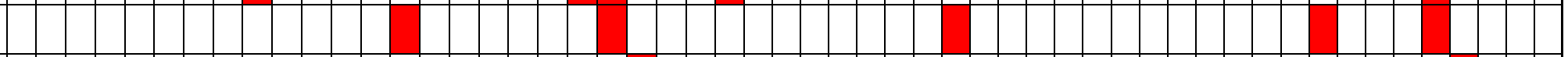
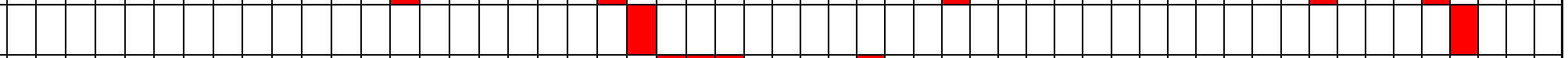
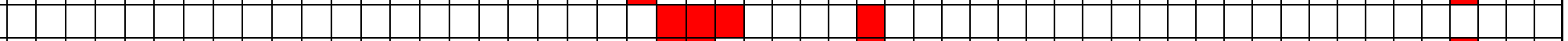
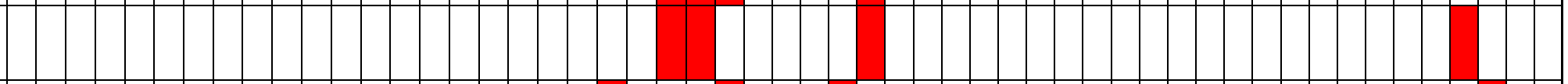
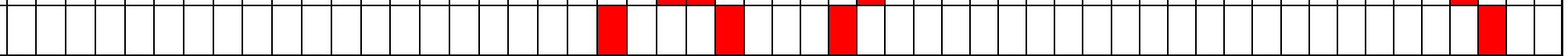
ENVIRONMENTAL PROTECTION	
HISTORY OF TECHNOLOGY	
INTELLECTUAL PROPERTY	
ECONOMY	
HUMANITIES/ ENONOMY SUBJECT (HES)	
FOREIGN LANGUAGE 1	
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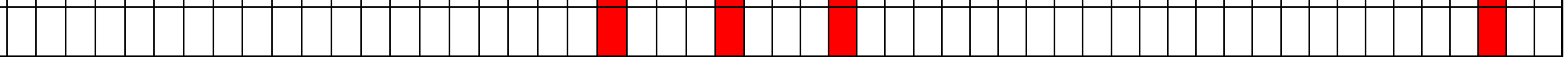
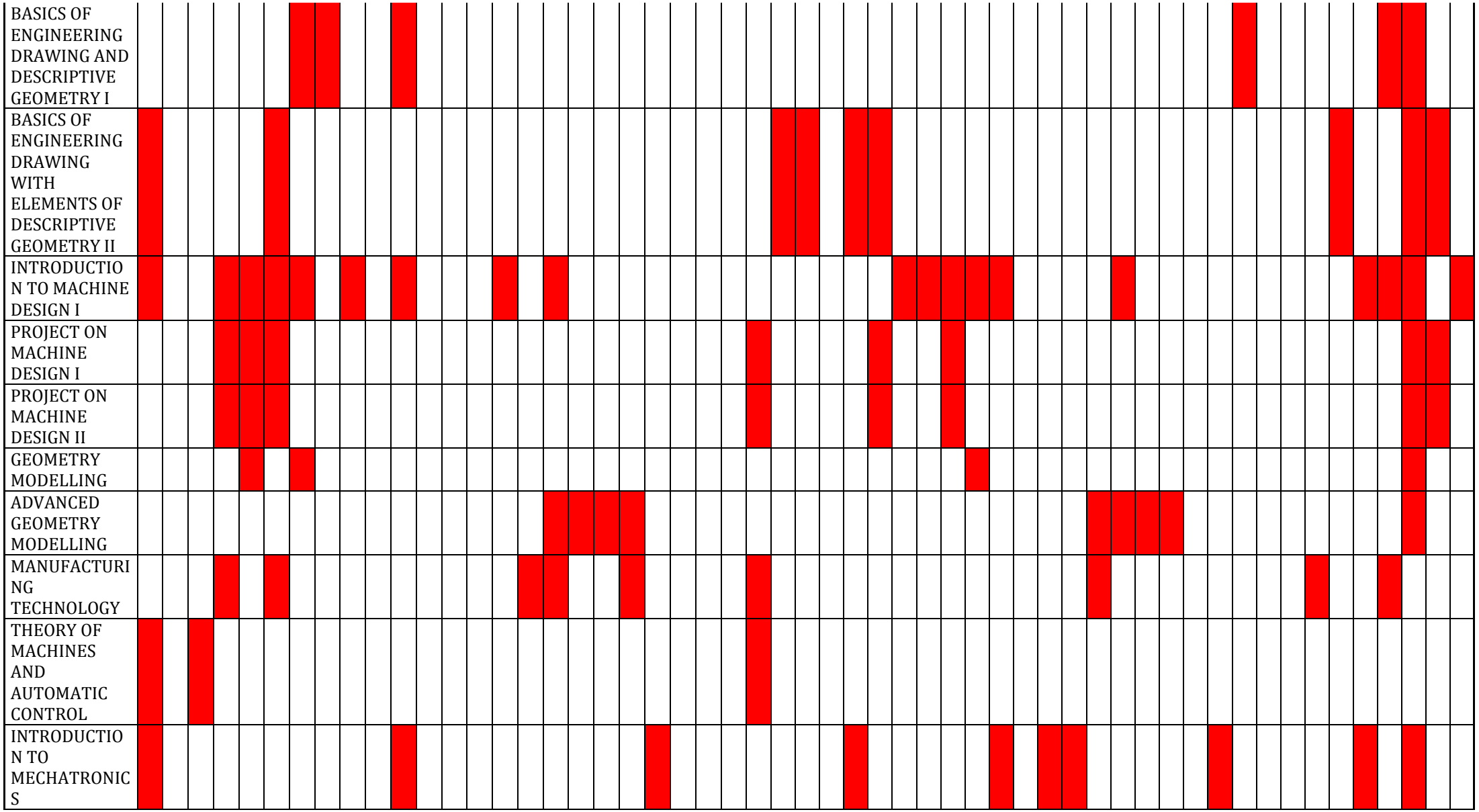
FOREIGN LANGUAGE 3	
IV.1.3. PRZEDMIOTY KIERUNKOWE	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BASICS OF ENGINEERING DRAWING WITH ELEMENTS OF DESCRIPTIVE GEOMETRY II
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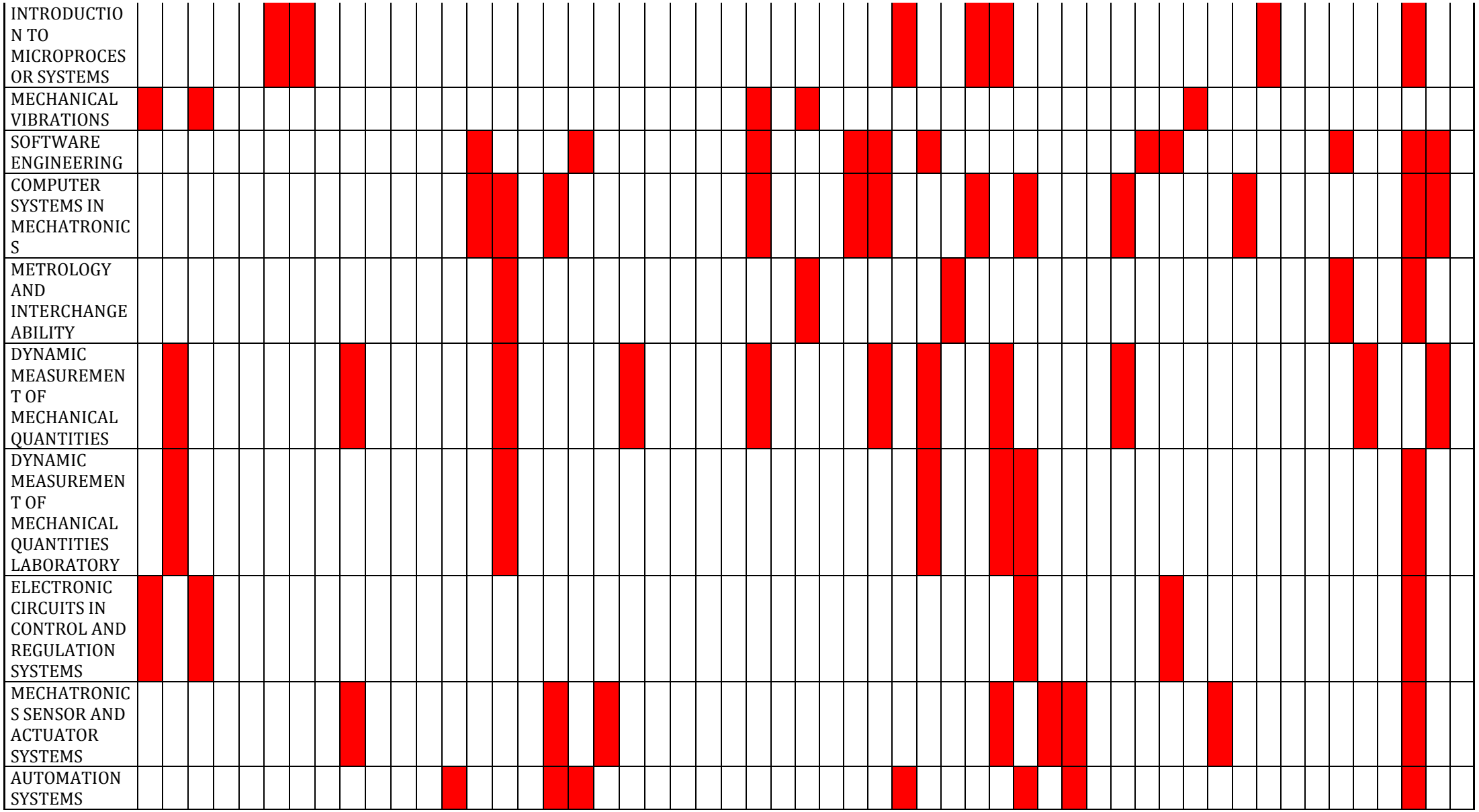
PROJECT ON MACHINE DESIGN I
PROJECT ON MACHINE DESIGN II
GEOMETRY MODELLING
ADVANCED GEOMETRY MODELLING
MANUFACTURI NG TECHNOLOGY
THEORY OF MACHINES AND AUTOMATIC CONTROL
INTRODUCTIO N TO MECHATRONIC S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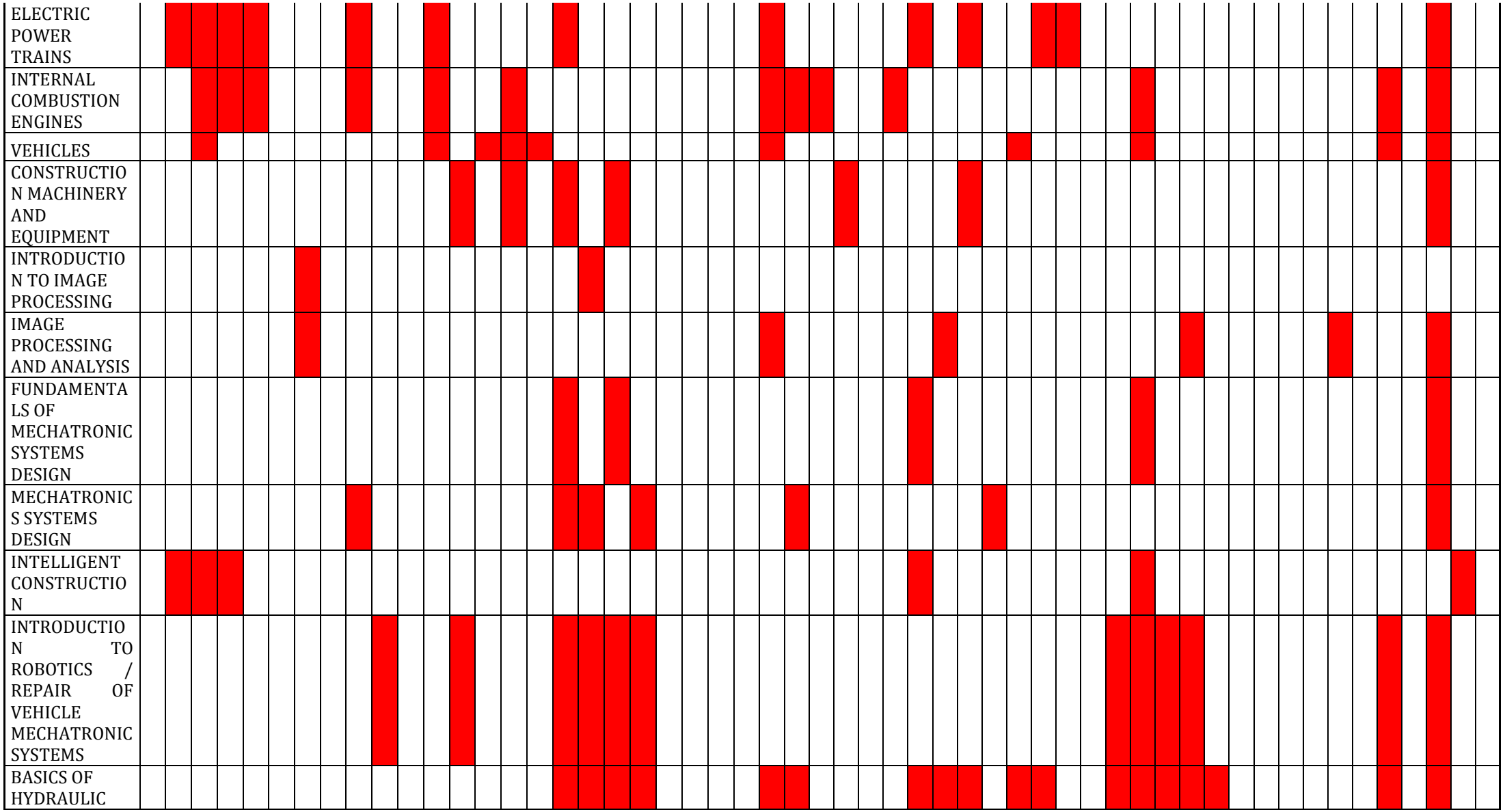
MECHANICAL VIBRATIONS
SOFTWARE ENGINEERING
COMPUTER SYSTEMS IN MECHATRONICS
METROLOGY AND INTERCHANGEABILITY
DYNAMIC MEASUREMENT OF MECHANICAL QUANTITIES
DYNAMIC MEASUREMENT OF MECHANICAL QUANTITIES LABORATORY
ELECTRONIC CIRCUITS IN CONTROL AND REGULATION SYSTEMS
MECHATRONICS SENSOR AND ACTUATOR SYSTEMS
AUTOMATION SYSTEMS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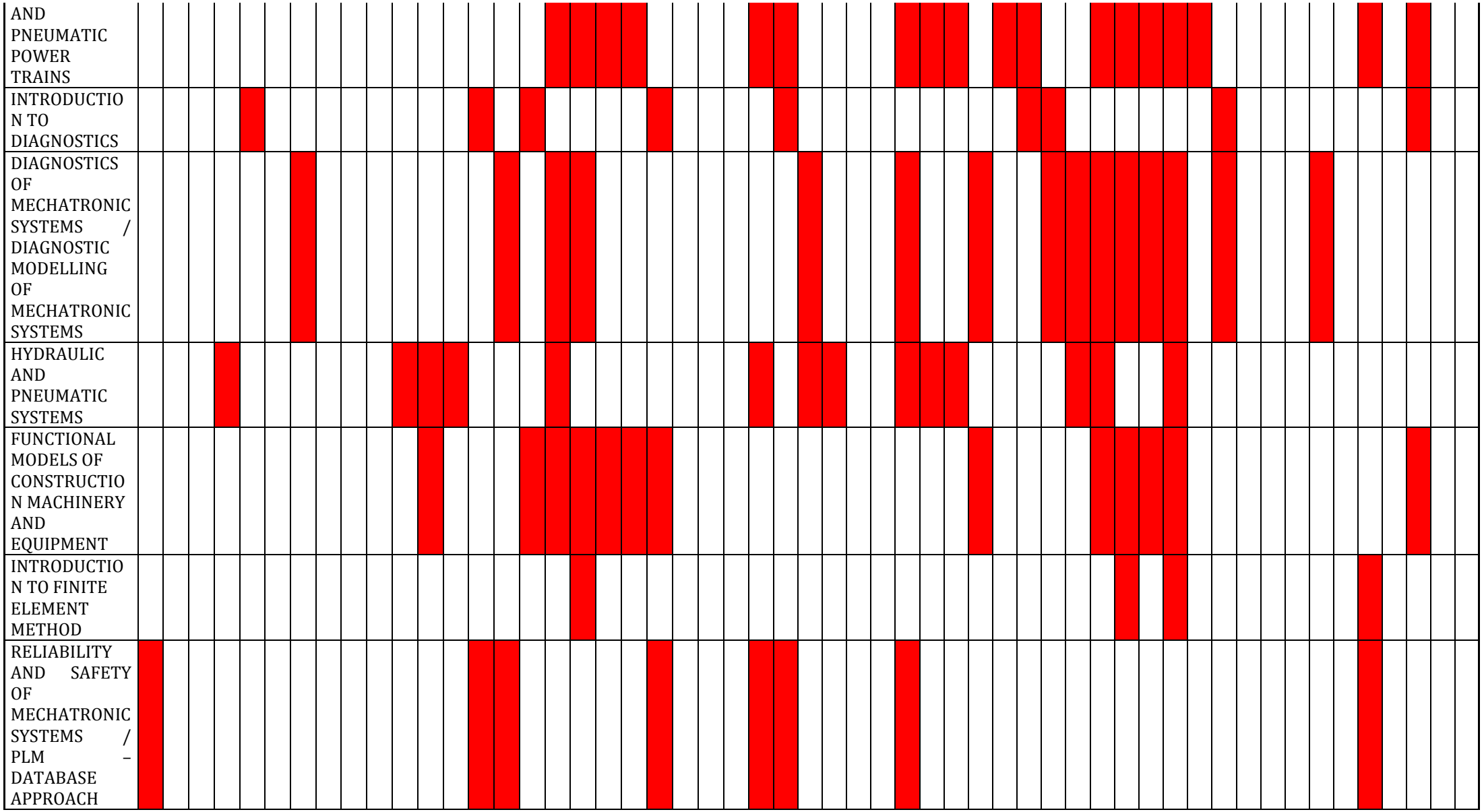
INTERNAL COMBUSTION ENGINES
VEHICLES
CONSTRUCTION MACHINERY AND EQUIPMENT
INTRODUCTION TO IMAGE PROCESSING
IMAGE PROCESSING AND ANALYSIS
FUNDAMENTALS OF MECHATRONIC SYSTEMS DESIGN
MECHATRONICS SYSTEMS DESIGN
INTELLIGENT CONSTRUCTION
INTRODUCTION TO ROBOTICS / REPAIR OF VEHICLE MECHATRONIC SYSTEMS
BASICS OF HYDRAULIC


AND PNEUMATIC POWER TRAINS
INTRODUCTION TO DIAGNOSTICS
DIAGNOSTICS OF MECHATRONIC SYSTEMS / DIAGNOSTIC MODELLING OF MECHATRONIC SYSTEMS
HYDRAULIC AND PNEUMATIC SYSTEMS
FUNCTIONAL MODELS OF CONSTRUCTION MACHINERY AND EQUIPMENT
INTRODUCTION TO FINITE ELEMENT METHOD
RELIABILITY AND SAFETY OF MECHATRONIC SYSTEMS / PLM – DATABASE APPROACH

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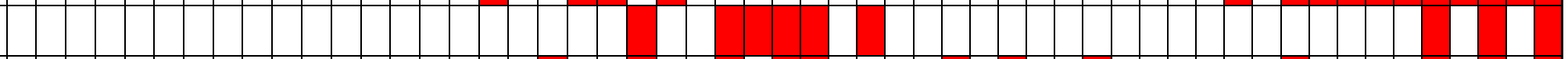
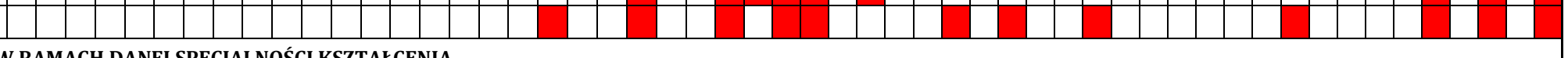
DIPLOMA SEMINAR	
THESIS	
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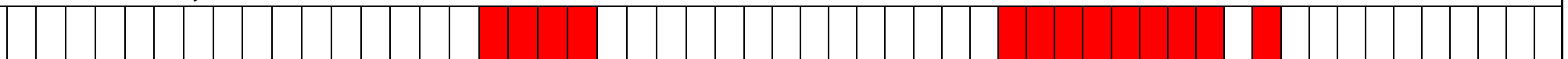
SPECJALNOŚĆ: MECHATRONIKA POJAZDÓW	
VEHICLE MECHATRONICS	
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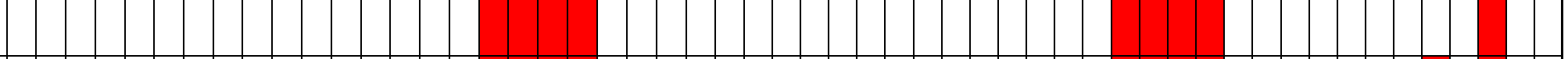
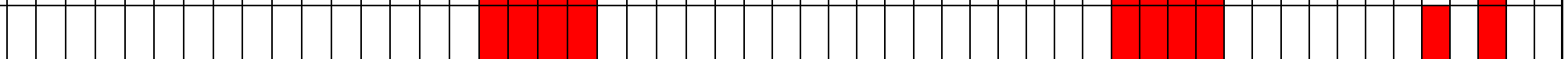
ON-BOARD DIAGNOSTICS OF VEHICLES	
AUTONOMOUS VEHICLES	
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VEHICLE ACOUSTICS	
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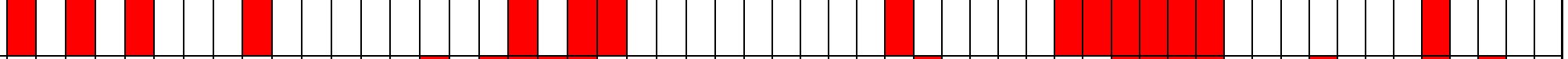
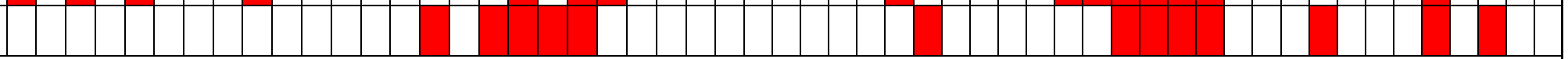
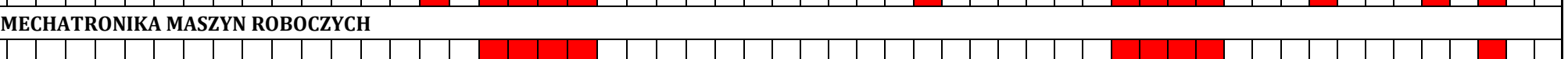
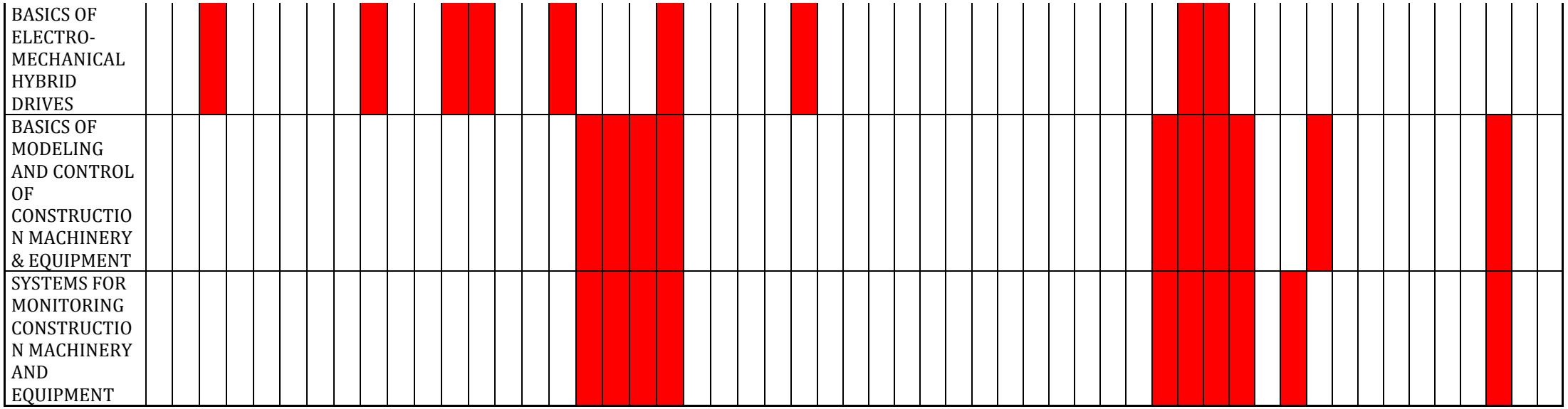
AUTOMATION OF CONSTRUCTION MACHINERY AND EQUIPMENT	
CONSTRUCTION MACHINERY	
PASSENGER LIFTS	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BASICS OF MODELING AND CONTROL OF CONSTRUCTION MACHINERY & EQUIPMENT
SYSTEMS FOR MONITORING CONSTRUCTION MACHINERY AND EQUIPMENT