

Military University of Technology, Warsaw, Poland
Faculty of Mechanical Engineering
Field of study: Mechanics and Machinery Design

COURSES OFFERED FOR ERASMUS+ STUDENTS IN THE ACADEMIC YEAR 2026/2027

Semester: W – Winter (October – February), S – Summer (March – July)

No.	Course name	Course code	Studies	Semester	Hours	ECTS	Form of credit	Lecturer	Teaching unit
1	PROGRAMMABLE CONTROL OF MECHATRONICS SYSTEMS	WMEMXCSE-19Z1-PCMS	B.Sc./M.Sc.	W	30	4	Pass	R. Typiak	IRMD
2	FUNDAMENTALS OF MACHINERY DESIGN 1	WMEMXCSE-19Z1-FMD1	B.Sc.	W	34	4	Exam	J. Torzewski	IRMD
3	FUNDAMENTALS OF MACHINERY DESIGN 2	WMEMXCSE-23Z1-FMD2	B.Sc.	S	30	3,5	Exam	J. Torzewski	IRMD
4	HYDRAULIC SYSTEMS FOR MOBILE APPLICATIONS	WMEMXCSE-19Z1-HSMA	B.Sc.	W	45	5,5	Pass	M.Dejewski	IRMD
5	FUNDAMENTALS OF FLUID MECHANICS	WMEMXCSE-25Z1-FFM	B.Sc.	S	30	4	Pass	A. Rubiec	IRMD
6	3D DESIGN IN CATIA	WMEMXCSE-25Z1-3DC	B.Sc.	S	45	4	Pass	K. Cieřlik	IRMD
7	DYNAMICS SIMULATIONS WITH MULTIBODY SOFTWARE	WMEMXCSE-25Z1-DSMS	B.Sc.	S	44	4	Pass	A. Rubiec	IRMD
8	ASSEMBLY DESIGN IN CATIA	WMEMXCSE-25Z1-ADC	B.Sc.	S	45	4	Pass	M. Przybysz	IRMD
9	CONSTRUCTION AND EARTHMOVING EQUIPMENT	WMEMXCSE-25Z1-CEE	B.Sc.	S	44	4	Pass	M. Łopatka	IRMD
10	THEORY OF LAND LOCOMOTION	WMEMXCSE-25Z1-TLL	B.Sc.	S	44	4	Pass	M. Łopatka	IRMD
11	DESIGN OF ROBOTS MANIPULATORS AND CONSTRUCTION EQUIPMENT ATTACHMENTS	WMEMXCSE-25Z1-DRMCEA	B.Sc.	S	45	4	Pass	P. Krogul	IRMD
12	ADDITIVE MANUFACTURING TECHNOLOGIES	WMEMXCSE-25Z1-AMT	B.Sc./M.Sc	S	44	4	Pass	J. Kluczyński	IRMD

13	ALTERNATIVE PROPULSION SYSTEMS	WMEMXCSE-19Z1-APS	B.Sc./M.Sc.	W	30	3,5	Exam	F. Polak	IVT
14	HYBRID AND ELECTRIC PROPULSION SYSTEMS	WMEMXCSE-24Z1-FVNM	B.Sc./M.Sc.	S	30	4	Exam	F. Polak	IVT
15	ENGINES OF MECHANICAL VEHICLES	WMEMXCSE-25Z1-EMV	B.Sc./M.Sc.	S	30	4	Exam	F. Polak	IVT
16	COMBUSTION ENGINES AND HYBRID PROPULSION SYSTEMS	WMEMXCSE-19Z1-CEHPS	B.Sc.	W/S	48	6	Pass	F. Polak J. Chojnowski	IVT
17	HYBRID AND ELECTRIC VEHICLES MAINTENANCE AND SAFETY	WMEMXCSE-19Z1-HEVMS	B.Sc./M.Sc.	W/S	20	2,5	Pass	F. Polak	IVT
18	VEHICLE DRIVETRAIN	WMEMXCSE-25Z1-VD	B.Sc.	W/S	30	4	Pass	J. Chojnowski	IVT
19	ASPECTS OF ROAD TRANSPORT OF HAZARDOUS MATERIALS	WMEMXCSE-25Z1-ARTHM	B.Sc./M.Sc.	W/S	20	2,5	Pass	J. Chojnowski	IVT
20	TRANSPORT OF GOODS	WMEMXCSE-25Z1-TG	B.Sc./M.Sc.	W/S	20	2,5	Pass	J. Chojnowski	IVT
21	CONSTRUCTION OF MILITARY VEHICLES	WMEMXCSE-19Z1-CMV	B.Sc./M.Sc.	W	30	3,5	Exam	K. Papliński	IVT
22	CONSTRUCTION AND OPERATION OF STABILISERS AND FCS	WMEMXCSE-24Z1-COS	B.Sc./M.Sc.	S	20	2,5	Pass	K. Papliński	IVT
23	INTRODUCTION TO DYNAMICS AND CONTROL SYSTEMS OF AUTOMOBILES	WMEMXCSE-19Z1-IDCSA	B.Sc./M.Sc.	W	30	3,5	Pass	D. Żardecki	IVT
24	INTRODUCTION TO AUTOMATICS AND ROBOTICS	WMEMXCSE-23Z1-IAR	B.Sc./M.Sc.	S	30	3,5	Pass	D. Żardecki	IVT
25	MECHANICAL VIBRATIONS	WMEMXCSE-19Z1-MV	B.Sc.	W	30	4	Pass	Z. Hryciów	IVT
26	MEANS OF TRANSPORT AND DISTRIBUTION OF FUELS	WMEMXCSE-26Z1-MTDF	B.Sc./M.Sc.	W/S	36	4	Pass	K. Gocman	IVT
27	INNOVATIONS IN FRICTION, WEAR AND LUBRICATION PROCESSES	WMEMXCSE-25Z1-IFWLP	B.Sc./M.Sc.	W/S	26	3	Pass	K. Gocman	IVT
28	FUNDAMENTALS OF TRIBOLOGY	WMEMXCSE-25Z1-FT	B.Sc.	W	30	4	Exam	T. Kałdoński	IVT
29	INTRODUCTION TO LABVIEW AND MEASUREMENTS	WMEMXCSE-25Z1-ILM	B.Sc. /M.Sc.	S	30	4	Pass	A. Dębowski	IVT

30	VEHICLE DYNAMICS	WMEMXCSE-25Z1-VDY	B.Sc. /M.Sc.	S	30	4	Pass	M. Ziubiński	IVT
31	FUNDAMENTALS OF TECHNICAL DEVICES EXPLOITATION	WMEMXCSE-26Z1-FTDE	B.Sc.	W	40	4	Pass	J. Pszczółkowski	IVT
32	ENGINEERING MECHANICS 1	WMEMXCSE-23Z1-EM1	B.Sc.	W	36	4	Pass	Ł. Mazurkiewicz	IMCE
33	ENGINEERING MECHANICS 2	WMEMXCSE-23Z1-EM2	B.Sc.	S	42	4,5	Pass	P. Baranowski	IMCE
34	STRENGTH OF MATERIALS 1	WMEMXCSE-23Z1-SM1	B.Sc.	W	36	4	Pass	P. Szurgott	IMCE
35	STRENGTH OF MATERIALS 2	WMEMXCSE-23Z1-SM2	B.Sc.	S	42	4,5	Exam	P. Kędzierski	IMCE
36	FEM AND SIMULATION OF LINEAR PROBLEMS OF MECHANICS	WMEMXCSE-23Z1-FSLPM	B.Sc./M.Sc.	W/S	44	5,5	Pass	W. Krasoń	IMCE
37	MULTIBODY SIMULATION IN MECHANICAL ENGINEERING	WMEMXCSE-25Z1-MSME	B.Sc. /M.Sc.	W/S	36	4	Pass	W. Krasoń	IMCE
38	FUNDAMENTALS OF VALIDATION OF NUMERICAL MODELS	WMEMXCSE-24Z1-FVNM	B.Sc.	W/S	30	4	Pass	G. Sławiński	IMCE
39	NUMERICAL MODELLING OF MATERIALS	WMEMXCSE-23Z1-NMM	B.Sc.	S	30	4,5	Pass	D. Miedzińska	IMCE
40	MANUFACTURING TECHNOLOGY	WMEMXCSE-23Z1-MT	B.Sc.	W	30	4,5	Pass	D. Miedzińska	IMCE
41	NON DESTRUCTIVE TESTING TECHNIQUES IN ENGINEERING	WMEMXCSE-25Z1-NDTTE	M.Sc.	W/S	30	4	Pass	A. Leski	IMCE
42	EXPERIMENTAL TECHNIQUES OF MATERIALS AND STRUCTURES TESTING	WMEMXCSE-24Z1-ETM	M.Sc.	S	32	3	Pass	P. Bogusz	IMCE

Teaching units:

IRMD – Institute of Robots and Machine Design

IVT – Institute of Vehicles and Transportation

IMCE – Institute of Mechanics and Computational Engineering

Language, level: English, B2

Subject: PROGRAMMABLE CONTROL OF MECHATRONICS SYSTEMS Faculty: Mechanical Engineering Department: Institute of Robots and Machine Design	
Studies: B.Sc./M.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter	30	14/+	—	16/+	—	—
ECTS points				4		

Author(s): Rafał TYPIAK, Ph.D., Eng
Leading lecturer: Rafał TYPIAK, Ph.D., Eng

CONTENTS

Introduction to PLCs. The hardware configuration of PLCs. Communication in the PLC system. Representation of input data. Graphical and textual programming languages.

EFFECTS OF EDUCATION

The student has basic knowledge of computer architecture and the methodology and techniques of programming.
The student knows the basics of programming controllers to the extent necessary to design digital control systems used in power equipment.
The student is able to formulate the algorithm and use low-level languages for programming controllers working in energy systems.

Subject: FUNDAMENTALS OF MACHINERY DESIGN 1	
Faculty: Mechanical Engineering	
Department: Institute of Robots and Machine Design	
Studies: B.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter	34	16/x	18/+	—	—	—
ECTS points				4		

Author(s): Janusz TORZEWSKI, Ph.D. Eng
Leading lecturer: Janusz TORZEWSKI, Ph.D. Eng

CONTENTS

Fatigue strength, definitions, determining of fatigue strength. Checking calculations, determining a real factor of safety. Design of mechanical elements. Permanent joints, kind of joints, calculation of riveted joints. Welded joints, types, computational dimensions of joints, calculating joints at fixed and variable loadings. Screw joints, thread contour, standardization, forces operating in the screw joint, strength calculations of screws and the thread. Elastic joints: types of joints, calculation of basic dimensions, strength calculations. Pin joints: classification, principles of design engineering.

EFFECTS OF EDUCATION

To teach about:

Influence of loadings on the machine elements, fatigue strength, design methodology, to introduce the calculation and selection of several specific machine elements that are fundamental to a wide range of engineering.

To acquaint with:

- selection of engineering materials for specific machine elements;
- calculation of various machine elements;
- scope of available technologies to the designer.

Subject: FUNDAMENTALS OF MACHINERY DESIGN 2	
Faculty: Mechanical Engineering	
Department: Institute of Robots and Machine Design	
Studies: B.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	30	16/x	14/+	—	—	—
ECTS points				3,5		

Author(s): Janusz TORZEWSKI, Ph.D. Eng
Leading lecturer: Janusz TORZEWSKI, Ph.D. Eng

CONTENTS

Axles and shafts: classification, principles of design and shaping axles and shafts, strength calculations. Clutches, types of clutches (couplings): rigid couplings, flexible couplings, friction clutches, calculating basic dimensions of clutches. Rolling bearings: standardization and division of bearings, load distribution in rolling bearings, durability and capacity of roller bearings, an assortment of rolling bearings, principles of assembling of bearings. Slide bearings: classification, types of friction in bearings, distribution of pressures on the circumference of shaft neck in case of semi-dry friction. Belt and chain transmission, structure, calculations, selection. Toothed gears: division, meshing laws, tooth cycle, conjugate tooth profile, tooth contact ratio. Basic rack tooth profile, transitional line of tooth flank, limiting the number of teeth, correction of teeth. Strength calculations of gear transmissions. Equivalent loads. Bending calculation, surface strength calculation, thermal calculation.

EFFECTS OF EDUCATION

To teach about:

Design and manufacture of mechanical elements in machine building. Strength calculations using computer-aided design of machines.

To acquaint with:

- design basis of selected parts and assemblies of machines,
- determining the design features of the machine systems through design,
- use the knowledge base in engineering design.

Subject: HYDRAULIC SYSTEMS FOR MOBILE APPLICATIONS Faculty: Mechanical Engineering Department: Institute of Robots and Machine Design	
Studies: B.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter	45	18/+	18/+	9/+	—	—
ECTS points				5,5		

Author(s): Marcin DEJEWSKI, M.Sc. Eng
Leading lecturer: Marcin DEJEWSKI, M.Sc. Eng

CONTENTS

Basics of hydrostatics and hydrodynamics. Functional diagrams. Displacement pumps and motors – construction and characteristic. Hydraulic cylinders. Working liquids. Filtration. Design of power hydrostatic drives. Hydrostatic systems control. Hydrokinetic elements – construction and characteristic, criteria of choice.

EFFECTS OF EDUCATION

Theoretical knowledge of processes and phenomena proceeding in hydraulic systems, construction of elements used in hydraulic drives and control systems and maintenance principles of hydraulic drives and control systems in mobile applications.

Practical skill in designing simple hydraulic systems for mobile applications and choosing hydraulic elements, filtration systems and working liquids.

Subject: FUNDAMENTALS OF FLUID MECHANICS	
Faculty: Mechanical Engineering	
Department: Institute of Robots and Machine Design	
Studies: B.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	30	14/+	8/+	8/+	—	—
ECTS points				4		

Author(s): Arkadiusz RUBIEC, Ph.D. Eng
Leading lecturer: Arkadiusz RUBIEC, Ph.D. Eng

CONTENTS

Introduction to fluid mechanics. Properties of fluids. Pressure and fluid statics. Hydrostatic forces acting on the plane. Buoyancy and stability of floating bodies. Euler equation. Conservation of mass. Bernoulli principle. Impact of Jet apparatus. Vapour pressure and cavitation. Navier – Stokes equation. Flow in pipes. Reynold's number. Laminar and turbulent flow. Bernoulli principle modification for viscous fluids. Losses in pipes. Introduction to flow over bodies.

EFFECTS OF EDUCATION

To gain fundamental knowledge about:

- The origin and meaning of fluid mechanics,
- Theoretical description and analysis of pressure and hydrostatic forces,
- Basic knowledge and investigation methods of stability of floating bodies,
- Theoretical description of energy conservation principle in fluids,
- Theoretical knowledge about viscous fluids flow in pipes and its investigation methods.

Subject: 3D DESIGN IN CATIA Faculty: Mechanical Engineering Department: Institute of Robots and Machine Design	
Studies: B.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	45	5/+	—	40/+	—	—
ECTS points				4		

Author(s): Karol CIEŚLIK, Ph.D. Eng
Leading lecturer: Karol CIEŚLIK, Ph.D. Eng

CONTENTS

Working principles in the CATIA software. CATIA Sketch chosen functions. CATIA Part Design chosen function.
Modelling solid objects using a Sketch. Modelling solid objects by modifying the 3D model. Hybrid modelling.
Analysis of model correctness. Creating technical documentation based on the 3D model.

EFFECTS OF EDUCATION

To gain fundamental knowledge about:

- Created and modelling 3D parts,
- Possibilities of using software for designing and modelling elements,
- Rules for creating technical documentation,
- Modeling of 3D parts based on technical documentation.

Subject: DYNAMICS SIMULATIONS WITH MULTIBODY SOFTWARE	
Faculty: Mechanical Engineering	
Department: Institute of Robots and Machine Design	
Studies: B.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	44	10/+	—	14/+	20/#	—
ECTS points				4		

Author(s): Arkadiusz RUBIEC, Ph.D. Eng
Leading lecturer: Arkadiusz RUBIEC, Ph.D. Eng

CONTENTS

The theoretical background of machine dynamics. Degrees of freedom. Lagrange vs d'Alembert methods. Principles of modelling using multibody software. Simplifying assumptions. Multibody model structure. Global and local coordinates systems. Adding parts (geometry and mass properties). Joints modelling (ideal and with friction). Joint and general motions. Applied forces and torques modelling. Flexible connections between parts (translational and rotational with linear and nonlinear characteristics). Design variables and local measures. Numerical step size setting. Simulations and results analysis.

EFFECTS OF EDUCATION

To gain fundamental knowledge about:

- Meaning of dynamics,
- Principles of machine dynamics modelling,
- Theoretical knowledge about equations of motion,
- Basic knowledge and investigation methods of dynamics simulations using Multibody software,
- Simulations results analysis,
- Practical use of multibody software in the machinery design process.

Subject: ASSEMBLY DESIGN IN CATIA Faculty: Mechanical Engineering Department: Institute of Robots and Machine Design	
Studies: B.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	45	5/+	—	40/+	—	—
ECTS points				4		

Author(s): Mirosław PRZYBYSZ, Ph.D. Eng
Leading lecturer: Mirosław PRZYBYSZ, Ph.D. Eng

CONTENTS

Creating 3D parts. Creating of assembly. Kinematic analysis of mechanisms. Simulation of mechanism movement. Analysis of structural strength. Creating technical drawings.

EFFECTS OF EDUCATION

To gain fundamental knowledge about:

- Creating mechanism assemblies,
- Analysis of mechanism kinematics and working range,
- FEM analysis in Catia v5.

Subject: CONSTRUCTION AND EARTHMOVING EQUIPMENT	
Faculty: Mechanical Engineering	
Department: Institute of Robots and Machine Design	
Studies: B.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	44	16/+	4	16/+	—	8/+
ECTS points				4		

Author(s): Marian ŁOPATKA, Ph.D., D.Sc. Eng
Leading lecturer: Marian ŁOPATKA, Ph.D., D.Sc. Eng

CONTENTS

Soil and ground properties. Tracked and wheeled tractors' construction and performance. Construction and operation of bulldozers, loaders, graders, scrapers, excavators, hauliers and cranes. Calculation of loads and main parameters of construction and earth-moving equipment. Chosen problems of research and development. Productivity and efficiency of operation. Estimation of operation cost.

EFFECTS OF EDUCATION

To gain fundamental knowledge about:

- Soil and ground properties,
- Construction of tractors and attachments,
- Driveline selection,
- Methods of operational loads determining,
- Methods of operational cost estimation.

Subject: THEORY OF LAND LOCOMOTION	
Faculty: Mechanical Engineering	
Department: Institute of Robots and Machine Design	
Studies: B.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	44	16/+	12	8/+	—	8/+
ECTS points				4		

Author(s): Marian ŁOPATKA, Ph.D., D.Sc. Eng
Leading lecturer: Marian ŁOPATKA, Ph.D., D.Sc. Eng

CONTENTS

Mechanics of tracks and pneumatic tires. Traction, grade and rolling resistance – motion limitation. Drivelines of vehicles. Construction and calculation of steering systems of tracked and wheeled vehicles. Vehicle stability. High mobility demand. Estimation of ground pressure and terrain mobility. Construction of wheeled and tracked gear systems. Gear system selection. Engine and transmission selection. Pulling power and efficiency. Stability of movement. Vehicle ride models.

EFFECTS OF EDUCATION

To gain fundamental knowledge about:

- Mechanics of wheels and tracks,
- Construction and properties of gear systems,
- Selection of engine and driveline,
- High mobility demand,
- Vehicle modelling.

Subject: DESIGN OF ROBOTS MANIPULATORS AND CONSTRUCTION EQUIPMENT ATTACHMENTS Faculty: Mechanical Engineering Department: Institute of Robots and Machine Design	
Studies: B.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	45	10/+	—	—	35/#	—
ECTS points				4		

Author(s): Piotr KROGUL, Ph.D. Eng
Leading lecturer: Piotr KROGUL, Ph.D. Eng

CONTENTS

Design basics of robot manipulators and construction equipment attachments. Chosen problems of a drive system design of robot manipulators and construction equipment attachments. Analytical and computer design methods of robot manipulators and construction equipment attachments (MSC Adams, Catia V5, Easy 5). Strength analysis in the design process of robot manipulators and construction equipment attachments with the use of the finite element method. Kinematic design of robot manipulators and construction equipment attachments.

EFFECTS OF EDUCATION

To gain fundamental knowledge about:

- Design basics of robots manipulators and construction equipment attachments,
- Chosen problems of a drive system design of robots manipulators and construction equipment attachments,
- Analytical and computer design methods of robots manipulators and construction equipment attachments (MSC Adams, Catia V5, Easy 5),
- Strength analysis in the design process of robots manipulators and construction equipment attachments with the use of the finite element method,
- Kinematic design of robot manipulators and construction equipment attachments.

Subject: ADDITIVE MANUFACTURING TECHNOLOGIES Faculty: Mechanical Engineering Department: Institute of Robots and Machine Design	
Studies: B.Sc./M.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	44	10/+	16#	18+	—	—
ECTS points				4		

Author(s): Janusz KLUCZYŃSKI, Ph.D. Eng
Leading lecturer: Janusz KLUCZYŃSKI, Ph.D. Eng

CONTENTS

Definition, standards, classification and history of additive manufacturing and placement of this technology among other manufacturing methods. The role and importance of stereolithographic tessellation. File formats used in additive manufacturing. Basics of “design for additive manufacturing (DfAM)” method. Additive manufacturing of polymers - description of VPP, MEX, PBF, BJ, SL techniques. Additive manufacturing of metals - description of DED, LB/EB techniques - PBF, MEX, SL. Development trends in additive manufacturing. Introduction to DfAM in Autodesk Fusion 360. Introduction to generative design in Autodesk Fusion 360.

EFFECTS OF EDUCATION

To gain fundamental knowledge about:

- Different additive manufacturing technologies for polymeric and metallic materials.
- Standards and file formats used in additive manufacturing.
- “Design for Additive Manufacturing” (DfAM) methodology.
- Additive manufacturing techniques for polymers: VPP (Vat Photopolymerization), MEX (Material Extrusion), PBF (Powder Bed Fusion), BJ (Binder Jetting).
- Additive manufacturing techniques for metals: DED (Directed Energy Deposition), LB/EB-PBF (Laser Beam / Electron Beam Powder Bed Fusion), MEX (Material Extrusion)
- Usage of additive manufacturing for industrial applications.

Subject: ALTERNATIVE PROPULSION SYSTEMS Faculty: Mechanical Engineering Department: Institute of Vehicles and Transportation	
Studies: B.Sc./M.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter	30	16/x	8/+	6/+	—	—
ECTS points				3,5		

Author(s): Filip POLAK, Ph.D. Eng
Leading lecturer: Filip POLAK, Ph.D. Eng

CONTENTS

Alternative propulsion systems – introduction. Alternative fuels for automotive applications. Hydrogen storage systems. Jet propulsion and rotary engines. Hybrid vehicle parameters and characteristics. Electric engine parameters and characteristics. Fuel cells in vehicles. Hydrogen-powered vehicles. Matching propulsion system to a vehicle. Energy storage systems. Matching battery to a vehicle. Electrical HV safety during vehicle maintenance. Ecological problems of alternative propulsion systems.

EFFECTS OF EDUCATION

To teach:

- construction of hybrid vehicles,
- construction of electric vehicles,
- fuel cells in vehicles and hydrogen storage systems.

To acquaint with:

- matching engine to a vehicle,
- matching battery to a vehicle.

Subject: HYBRID AND ELECTRIC PROPULSION SYSTEMS	
Faculty: Mechanical Engineering	
Department: Institute of Vehicles and Transportation	
Studies: B.Sc./M.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	30	16/x	8/+	6/+	—	—
ECTS points				4		

Author(s): Filip POLAK, Ph.D. Eng
Leading lecturer: Filip POLAK, Ph.D. Eng

CONTENTS

Hybrid and electric propulsion systems – introduction. Hybrid vehicle parameters and characteristics. Electric engine parameters and characteristics. Fuel cells in vehicles. Hydrogen storage systems. Matching propulsion system to a vehicle. Energy storage systems. Matching battery to a vehicle. Charging systems. Electrical infrastructure for electric vehicles. Electrical HV safety during vehicle maintenance. Ecological problems of alternative propulsion systems.

EFFECTS OF EDUCATION

To teach:

- construction of hybrid vehicles,
- construction of electric vehicles,
- construction of charging systems,
- fuel cells in vehicles and hydrogen storage systems.

To acquaint with:

- matching engine to a vehicle,
- matching battery to a vehicle.

Subject: ENGINES OF MECHANICAL VEHICLES	
Faculty: Mechanical Engineering	
Department: Institute of Vehicles and Transportation	
Studies: B.Sc./M.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	30	16/x	6/+	8/+	—	—
ECTS points				4		

Author(s): Filip POLAK, Ph.D. Eng
Leading lecturer: Filip POLAK, Ph.D. Eng

CONTENTS

Working cycles of internal combustion engines. Internal and external combustion engines. The ideal air standard Otto, Diesel and dual (Sabathe or Seiliger) cycles. Comparison between thermodynamic and mechanical cycles. Indicator diagram of two and four-stroke engines. Engines parameters and characteristics. Engine performance parameters. Engine power. Engine efficiency. Comparison parameters of the engine. Engine heat balance. Parameters of air-fuel (A/F) ratio mixture. Carburettor and injection A/F mixture creation. A/F mixture ignition and combustion. Stages of combustion of a homogeneous mixture. Abnormal combustion – knocking. Factors affecting abnormal combustion. Fuel feeding in CI (compression ignition - diesel) engines. Creating of A/F mixture in CI engines. Fuel injection parameters. CI engine control. Stages of combustion of a heterogeneous mixture. Process of Self-ignition. Combustion chambers of CI engines. Governors function in CI engines. Construction of mechanic and electronic governors. Governor tasks in CI engines. Fuel dose correction. Air feeding of internal combustion engines. Engine charging. Induction and exhaust process in naturally-aspirated and forced inducted engines. Mechanical-charging and turbo-charging. Resonance charging. Ecological problems of IC engine work. Toxic components exhaust gases. Assessment methods for toxic emissions. Catalysts and exhaust filters. Noise.

EFFECTS OF EDUCATION

To teach:

- construction of main engine components,
- methods of finding of engine main parts load.

To acquaint with:

- matching engine to a vehicle.

Subject: COMBUSTION ENGINES AND HYBRID PROPULSION SYSTEMS	
Faculty: Mechanical Engineering	
Department: Institute of Vehicles and Transportation	
Studies: B.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	48	20/+	14/+	14/+	—	—
ECTS points				6		

Author(s): Filip POLAK, Ph.D. Eng
Leading lecturer: Filip POLAK, Ph.D. Eng, Janusz CHOJNOWSKI, Ph.D. Eng

CONTENTS

Classification of heat engines. Performance indicators of internal combustion engines. General construction and operation of internal combustion engine systems. General construction and operation of turbine engines in vehicle propulsion. Construction of piston rod systems. Construction of engine valve trains. Construction of power supply systems for spark-ignition engines. Construction of power supply systems of compression ignition engines. Construction of power supply systems. Construction of air supply, exhaust and supercharging systems. Hybrid drives. Solution of fuel cell solutions in vehicles. Electric drive systems in vehicles. Measurement of engine and drive system parameters.

EFFECTS OF EDUCATION

To teach:

- construction of main engine components,
- construction of hybrid vehicles,
- construction of electric vehicles,

To acquaint with:

- construction and assembly of main engine components.

Subject: HYBRID AND ELECTRIC VEHICLES MAINTENANCE AND SAFETY Faculty: Mechanical Engineering Department: Institute of Vehicles and Transportation	
Studies: B.Sc./M.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter/Summer	20	8/+	6/+	6/+	—	—
ECTS points				2,5		

Author(s): Filip POLAK, Ph.D. Eng
Leading lecturer: Filip POLAK, Ph.D. Eng

CONTENTS

Categories, types and construction of hybrid and electric vehicles. Construction of hybrid and electric powertrains of vehicles of different brands. Hazards and safe operation of hybrid and electric vehicles. Rules of conduct during service, diagnostics and evaluation of electric and hybrid vehicles. Electrical HV safety during vehicle maintenance.

EFFECTS OF EDUCATION

To teach:

- safety procedures during maintenance of hybrid and electric vehicles,
- construction of HV systems,
- construction of batteries safety systems,
- construction of onboard safety systems.

To acquaint with:

- safety procedures during vehicle maintenance,
- safety rules and first aid.

Subject: VEHICLE DRIVETRAIN Faculty: Mechanical Engineering Department: Institute of Vehicles and Transportation	
Studies: M.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter	30	16/+	8+	6/+	—	—
ECTS points				4		

Author(s): Janusz CHOJNOWSKI, Ph.D. Eng
Leading lecturer: Janusz CHOJNOWSKI, Ph.D. Eng

CONTENTS

Introduction to vehicle drivetrains. Classification and functions of drivetrain systems. Torque and power transmission from engine to wheels. Design and operation of main drivetrain components: clutch, gearbox, driveshaft, differential, and axles. Manual and automatic transmissions – structure and characteristics. All-wheel drive systems. Drivetrain layout configurations (FWD, RWD, AWD). Drivetrain matching to vehicle type and purpose. Efficiency and energy losses in power transmission. Introduction to drivetrain systems in hybrid and electric vehicles.

EFFECTS OF EDUCATION

To teach:

- Structure and function of key drivetrain components in vehicles.
- Differences between types of transmission systems.
- Influence of drivetrain layout on vehicle dynamics and performance.

To acquaint with:

- Principles of torque transmission in vehicle drivetrains.
- Methods of drivetrain design and selection.
- Basic diagnostic methods and efficiency evaluation of drivetrain systems.

Subject: ASPECTS OF ROAD TRANSPORT OF HAZARDOUS MATERIALS Faculty: Mechanical Engineering Department: Institute of Mechanical Vehicles and Transport	
Studies: B.Sc. M.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	20	12	8	-	—	—
ECTS points				2,5		

Author(s): Janusz Chojnowski, Ph.D. Eng
Leading lecturer: Janusz Chojnowski, Ph.D. Eng

CONTENTS

Selected legal and technical aspects of storage and road transport of hazardous substances in the EU. Types and characteristics of hazardous materials. Special marking and equipment of vehicles for the transport of dangerous substances. Principles of safe handling of hazardous substances in road transport. Hazardous transport exposure and methods of protection.

Full module description

- Selected legal and technical aspects of the storage and transport of hazardous substances by road in the European Union
 - Presentation and discussion of selected aspects of the ADR convention and EU legal acts related to the transport and storage of hazardous substances
- Types and physicochemical properties of hazardous materials
 - presentation of hazardous materials in accordance with the ADR classes method and an indication of their potential dangers
- Special marking and equipment of vehicles for the transport of hazardous substances.
 - Presentation and discussion of the need for special marking of vehicles carrying dangerous goods. Presentation of the equipment and construction differences of vehicles for the transport of hazardous substances. Discussion of the necessity to use specially prepared vehicles.
- Principles of safe handling of hazardous substances in road transport
 - Basics of planning and organizing the transport of dangerous materials and dangerous goods. Principles of road planning for the transporting vehicle.
- Dangerous exposure in transport and protection methods.
 - Overview of transport exposures not resulting from the kinetics of the vehicle and the method of cargo protection

EFFECTS OF EDUCATION

To gain fundamental knowledge about:

- carriage of dangerous goods for road transport,
- planning the transport of hazardous substances,
- choosing the right means of transport for the load,
- the effective and safe implementation of road transport tasks for dangerous goods.

Subject: TRANSPORT OF GOODS Faculty: Mechanical Engineering Department: Institute of Mechanical Vehicles and Transport	
Studies: B.Sc. M.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	20	12	8	-	—	—
ECTS points				2,5		

Author(s): Janusz Chojnowski, Ph.D. Eng
Leading lecturer: Janusz Chojnowski, Ph.D. Eng

CONTENTS

The course will cover the fundamental principles of road transport, including the types of vehicles used for goods transportation, the regulatory framework that governs road transport of goods, and the principles of logistics management.

EFFECTS OF EDUCATION

To gain fundamental knowledge about:

- the types of vehicles used in road transport of goods,
- the regulatory framework governing road transport of goods,
- the principles of logistics management and its role in the road transport of goods,
- the key factors that affect the efficiency of road transport of goods,
- the key challenges faced by road transport of goods.

Subject: CONSTRUCTION OF MILITARY VEHICLES Faculty: Mechanical Engineering Department: Institute of Vehicles and Transportation	
Studies: B.Sc./M.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter	30	15/x	15/+	—	—	—
ECTS points				3,5		

Author(s): Krzysztof PAPLIŃSKI, Ph.D. Eng
Leading lecturer: Krzysztof PAPLIŃSKI, Ph.D. Eng

CONTENTS

Vehicle's basic structure (application). Modularity. Hull structure. Drive frame. Powerpack (engine, transmission, cooling unit). Power line. Braking system. Steering system. Hydraulic system. Pneumatic system. NBC and air conditioning system.

EFFECTS OF EDUCATION

To teach:

- structure of the vehicle (the basic parts),
- construction of power pack and power line,
- construction of main systems of the vehicle.

To inform about:

- main operation rules.

Subject: CONSTRUCTION OF AND OPERATION OF STABILISERS AND FCS Faculty: Mechanical Engineering Department: Institute of Vehicles and Transportation	
Studies: B.Sc./M.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	20	10/+	10/+	—	—	—
ECTS points				2,5		

Author(s): Krzysztof PAPLIŃSKI, Ph.D. Eng
Leading lecturer: Krzysztof PAPLIŃSKI, Ph.D. Eng

CONTENTS

Requirements for fire control systems. Disturbances acting on the stabilized gun. Functional diagrams of fire control systems. Design and operation of sensors and actuators used in fire control systems. Principles of operation of some fire control systems.

EFFECTS OF EDUCATION

To teach:

- main structure of fire control systems,
- main components of fire control systems,
- functional diagrams of fire control systems.

To inform about:

- main operation rules of some fire control systems.

Subject: INTRODUCTION TO DYNAMICS AND CONTROL SYSTEMS OF AUTOMOBILES Faculty: Mechanical Engineering Department: Institute of Vehicles and Transportation	
Studies: B.Sc./M.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter	30	20/+	10/+	—	—	—
ECTS points				3,5		

Author(s): Dariusz ŻARDECKI, Ph.D., D.Sc. Eng
Leading lecturer: Dariusz ŻARDECKI, Ph.D., D.Sc. Eng

CONTENTS

A car as an element of the Driver-Vehicle-Road system and a complex dynamical system and an object of control.
A survey of methods of tests and analyses of car dynamics and control. Problems of modelling of car dynamics and control. Modelling of dynamics of vehicle motion. Modelling of actions of chosen car subsystems. Modelling of driver dynamics. Complex modelling of the dynamics of the Driver-Vehicle-Road system. Reference models for controllers for car automatic systems. Synthesis of algorithms for chosen car automatic systems.
Problems of dynamics and control of autonomic cars.

EFFECTS OF EDUCATION

To teach:

- Defining of model problems (in the time/frequency domain) due to car dynamics and control.

To acquaint students with:

- Modern methods of tests and analyses of car dynamics and control,
- Control theory and control system devices due to car lateral dynamics and control.

Subject: INTRODUCTION TO AUTOMATICS AND ROBOTICS Faculty: Mechanical Engineering Department: Institute of Vehicles and Transportation	
Studies: B.Sc./M.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	30	20/+	6/+	4/+	—	—
ECTS points				3,5		

Author(s): Dariusz ŻARDECKI, Ph.D., D.Sc. Eng
Leading lecturer: Dariusz ŻARDECKI, Ph.D., D.Sc. Eng

CONTENTS

General information about automatics and robotics (the idea of open / closed-loop control, SISO / MIMO structures, control/sensor devices, history and nowadays). Methods of modelling of linear/non-linear elements and systems (equations, characteristics, Laplace / Fourier transformations, transfer functions, schematic diagrams and their simplifications). Static and dynamic properties of elements and systems (time/frequency characteristics of elements, simplified analysis of systems with using characteristics of elements). Classic control systems and their elements (regulators and correctors, input/output devices). Analysis of control systems in the time/frequency domain (stability, indexes, sensitivity). Modern control systems (optimal/adaptive/robust control, digital processing, mechatronic input/output devices). Automatics for complex systems and processes (the hierarchical idea of control, universal controllers, computers and networks in automatics). Example applications of control systems and automatics (car, central heating, etc.). Robots and manipulators – general description (mechanical structures, problems of kinematics, dynamics and steering, programming by computer). Robots and manipulators in different branches (industry, science, medicine, military).

EFFECTS OF EDUCATION

To teach:

- defining of control tasks and systems, modelling of systems in time/frequency domains, carrying out of control system analysis.

To acquaint students with:

- control theory, control system devices, robots and manipulators, applications of automatics and robotics.

Subject: MECHANICAL VIBRATIONS	
Faculty: Mechanical Engineering	
Department: Institute of Vehicles and Transportation	
Studies: B.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter	30	14/+	8/+	8/+	—	—
ECTS points				4		

Author(s): Lt. Col. Zdzisław HRYCIÓW, Ph.D. Eng
Leading lecturer: Lt. Col. Zdzisław HRYCIÓW, Ph.D. Eng

CONTENTS

Fundamental concepts in vibration and modelling: Introduction to modelling and analysis, Introduction to mechanical vibration, Harmonic motion, Lagrange's equations. Free vibration of single degree of freedom systems: Undamped vibration, Simple harmonic motion, Damped vibration. Forced harmonic excitation of single degree of freedom systems: Undamped vibration, Damped vibration, Base excitation, Rotating unbalance, Coulomb damping. The vibration of multi-degree of freedom systems: Free undamped vibration, Eigenvalue problem, Free damped vibration, Forced vibration, Resonance. Reduction of vibrations: Vibration isolation, Transmissibility, Isolation Efficiency, Passive and active isolation systems. Influence of spring stiffness and damping coefficient on reduction of an amplitude of vibration or force transmitted by an object. Shaft vibration. The critical speed of the shaft. Vibration estimation: Frequency-domain methods, Evaluation of human exposure to whole-body and hand-transmitted vibrations. The use of simulation programs (MATLAB – Simulink) for dynamic analysis.

EFFECTS OF EDUCATION

This course is an introduction to the dynamics and vibrations of lumped-parameter models of mechanical systems. After this course, students will be able to: evaluate free and forced vibration of linear multi-degree of freedom models of mechanical systems and matrix eigenvalue problems, solve basic problems of vibration isolations and estimate the level of vibrations.

Subject: MEANS OF TRANSPORT AND DISTRIBUTION OF FUELS	
Faculty: Mechanical Engineering	
Department: Institute of Vehicles and Transportation	
Studies: B.Sc./M.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter/Summer	36	16/+	12/+	6/+	—	2/-
ECTS points				4		

Author(s): Lt. Col. Krzysztof GOCMAN, Ph.D. Eng
Leading lecturer: Lt. Col. Krzysztof GOCMAN, Ph.D. Eng

CONTENTS

Characteristics of the transport of fuels. Regulations concerning the transport and distribution of fuels.
 Characteristics of railroad tank cars and tank trucks for the transport and distribution of fuels. Pipeline transport of crude oil and fuels. Characteristics of pumps used in devices for the transport and distribution of fuels.
 Characteristics of flow-meters and nozzles used in devices for the transport and distribution of fuels. Modern trends in devices for transport and distribution of fuels.

EFFECTS OF EDUCATION

To gain fundamental knowledge about:

- Basic principles of the construction of devices for the transport and distribution of fuels,
- Basic maintenance characteristics of devices for the transport and distribution of fuels,
- Regulations concerning devices for transport and distribution of fuels,
- Safety, health, environment and fire protection in the transport and distribution of fuels.

Subject: INNOVATIONS IN FRICTION, WEAR AND LUBRICATION PROCESSES Faculty: Mechanical Engineering Department: Institute of Vehicles and Transportation	
Studies: B.Sc./M.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter/Summer	26	16/+	—	6/+	—	4/-
ECTS points				3		

Author(s): Lt. Col. Krzysztof GOCMAN, Ph.D. Eng
Leading lecturer: Lt. Col. Krzysztof GOCMAN, Ph.D. Eng

CONTENTS

Origin, meaning and development of tribology. Problems of friction and wear on the micro- and nanoscale. Microtribological and nanotribological systems (MEMS, NEMS, MSD). Modern lubricants. Research methods of tribological systems in micro and nanoscale. Chosen problems of biotribology.

EFFECTS OF EDUCATION

To gain fundamental knowledge about:

- The origin and meaning of micro/nanotribology,
- Theoretical description and analysis of friction, wear and lubrication processes in micro and nanoscale,
- Methods of investigation of mechanical properties of materials at the micro and nanoscale,
- Methods of investigations of friction, wear and lubrication processes in micro and nanoscale,
- Contemporary tribological problems, including micro- and nanotribology, biotribology.

Subject: FUNDAMENTALS OF TRIBOLOGY	
Faculty: Mechanical Engineering	
Department: Institute of Vehicles and Transportation	
Studies: B.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter	30	16/x	—	10/+	—	4/-
ECTS points				4		

Author(s): prof. Tadeusz KAŁDOŃSKI, Ph.D., D.Sc. Eng
Leading lecturer: prof. Tadeusz KAŁDOŃSKI, Ph.D., D.Sc. Eng

CONTENTS

Tribology in operation and maintenance of motor vehicles and transport devices. Tribological systems of motor vehicles and transport devices. Solids and liquids as construction elements of tribological systems. Processes of friction in tribological systems. Processes of tribological wear. Lubrication in tribological systems. Methods of investigations of friction and wear. Processes of the corrosive wear of tribological couples, theoretical basics of corrosion of metals.

EFFECTS OF EDUCATION

To gain fundamental knowledge about:

- Description and analysis of friction, wear and lubrication processes of elements of motor vehicles and transport Devices,
- Methods of investigations of friction, wear and lubrication processes of elements of motor vehicles and transport devices,
- Distinguishing of sorts of friction, wear and lubrication of elements of motor vehicles and transport devices,
- Preventing of wear of elements of motor vehicles and transport devices during their operation and maintenance.

Subject: INTRODUCTION TO LABVIEW AND MEASUREMENTS Faculty: Mechanical Engineering Department: Institute of Vehicles and Transport	
Studies: B.Sc./M.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter	30	10/+	—	20/+	—	—
ECTS points				4		

Author(s): Andrzej DĘBOWSKI, Ph.D. Eng
Leading lecturer: Andrzej DĘBOWSKI, Ph.D. Eng

CONTENTS

The course presents the application possibilities of NI hardware and software. Examples of applications enabling real-time measurements, advanced data processing and visualisation, and implementations of selected communication protocols will be presented. Students will learn to use the CompactRIO and DAQmx series of measurement devices.

EFFECTS OF EDUCATION

To gain fundamental knowledge about:

- The structure of a program made in the LabVIEW environment.
 - Operation of the CompactRIO and DAQmx measuring instruments.
 - Performing measurements with NI tools.
 - Analysis of measurement results and their graphical presentation.
 - Making programs in the installation version.
-

Subject: VEHICLE DYNAMICS Faculty: Mechanical Engineering Department: Institute of Vehicles and Transport	
Studies: B.Sc./M.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter	30	14/+	16+	—	—	—
ECTS points				4		

Author(s):

Mateusz ZIUBIŃSKI, Ph.D. Eng

Leading lecturer:

Mateusz ZIUBIŃSKI, Ph.D. Eng

CONTENTS

Fundamental terms of vehicle mechanics. Move resistance forces. Driving force and its generation. Engine torque vs power. Equation of vehicle's motion. Adhesion force and tire slippage. Available and required driving force. Traction characteristics and vehicle dynamics. Braking in emergency conditions. Basics of curvilinear motion. Principles of ABS, ASR, ESP systems operation. Tire side slip - understeer and oversteer vehicle. Condition of vehicle stability loss.

EFFECTS OF EDUCATION

To gain fundamental knowledge about:

- External forces acting on the moving vehicle.
 - Driving force and its dependence from drive train configuration.
 - Influence of engine characteristic (torque and power) on vehicle's performance,
 - Principles of vehicles' active safety systems (ABS, ASR, ESP) operation,
 - Tire grip and its influence of vehicle movement and stability.
-

Subject: FUNDAMENTALS OF TECHNICAL DEVICES EXPLOITATION	
Faculty: Mechanical Engineering	
Department: Institute of Vehicles and Transportation	
Studies: B.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter	40	24/+	16/+	—	—	—
ECTS points				4		

Author(s): Józef PSZCZÓŁKOWSKI, Ph.D., D.Sc. Eng
Leading lecturer: Józef PSZCZÓŁKOWSKI, Ph.D., D.Sc. Eng

CONTENTS

Basic processes of equipment exploitation. Aging and wear processes. Models of human interaction with equipment: use and maintenance. Concepts and principles of diagnostics. Analytical and symptomatic diagnostic models of equipment. Assessment of the condition of technical equipment. Features and characteristics of equipment reliability. Basic reliability distributions. Renewal models and system reliability characteristics. Planning the use, maintenance, and renewal of equipment. Models and methods for operational decision-making. Tools for planning operational processes and systems. Characteristics of operational processes. Operational availability of equipment. Exploitation strategies, principles of technical maintenance. Characteristics of the technical support for operation.

EFFECTS OF EDUCATION

Students will gain knowledge of the device life cycle, methods for collecting and processing operational data, and machine diagnostics that enable their proper exploitation. Students will have knowledge of the design and operating principles of machines, tribological processes, and reliability necessary to understand operational processes. Students will be familiar with methods for measuring quantities characterizing mechanical and electrical components and systems, and with methods for calculating signal characteristics necessary for analyzing the condition of objects. Students will be able to plan and conduct diagnostic measurements of physical quantities of devices, interpret the obtained results, and formulate conclusions regarding the assessment of device performance and reliability. Students will be familiar with the principles and able to plan and organize the process of device use, maintenance, and renewal.

Subject: ENGINEERING MECHANICS 1	
Faculty: Mechanical Engineering	
Department: Institute of Mechanics and Computational Engineering	
Studies: B.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter	36	18/+	18/+	—	—	—
ECTS points				4		

Author(s): prof. Jerzy MAŁACHOWSKI, Ph.D., D.Sc. Eng
Leading lecturer: Łukasz MAZURKIEWICZ, Ph.D. Eng

CONTENTS

General Principles. Units. Force Vectors. Scalars and Vectors. Vectors operations. Cartesian Vectors. Condition for the Equilibrium of a Particle. The Free-Body Diagram. Three-Dimensional Force Systems. Moment of a Force. Principle of Moments. Moment of a Force about a Specified Axis. Simplification of a Force and Couple System. Conditions for Rigid Equilibrium. Equations of Equilibrium. Constraints and Static Determinacy. Friction. Characteristics of Dry Friction. Rolling Resistance.

EFFECTS OF EDUCATION

Basic knowledge and ability to solve practical problems of statics of force systems, modelling mechanical systems, determination of static resultants. Friction problems. Static analysis of simple bar structures and mechanical systems. A student must pass one homework, three tests on exercises and one test on theory.

Subject: ENGINEERING MECHANICS 2	
Faculty: Mechanical Engineering	
Department: Institute of Mechanics and Computational Engineering	
Studies: B.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	42	20/+	22/+	—	—	—
ECTS points				4,5		

Author(s):
Leading lecturer:

prof. Jerzy MAŁACHOWSKI, Ph.D., D.Sc. Eng
Paweł BARANOWSKI, Ph.D., D.Sc. Eng

CONTENTS

Centre of Gravity and Centre of Mass for a System of Particles. Composite Bodies. Resultants of a General Distributed Loading. Moments of Inertia. Kinematics. Continuous Motion. Erratic Motion. General Curvilinear Motion. Rigid-Body Motion. Absolute Motion Analysis. Relative-Motion Analysis. Newton's Second Law of Motion. Equations of Motion: Rectangular Coordinates Equations of Motion: Normal and Tangential Coordinates. The Work of a Force. The Work of a Couple Moment. Principle of Work and Energy. Principle of Work and Energy for a System of Particles. Conservative Forces and Potential Energy. Conservation of Energy. Principle of Linear Impulse and Momentum. Conservation of Linear Impulse for a System of Particles. Angular Momentum. The relation between the Momentum of a Force and Angular Momentum. Undamped Free Vibration. Undamped Forced Vibration. Viscous Damped Free Vibration. Viscous Damped Forced Vibration.

EFFECTS OF EDUCATION

Basic knowledge and ability to solve kinematic and dynamic problems related to mass particles, rigid bodies and mechanical systems. Characterization of motion of particles and rigid bodies. Dynamic principles of mass particles systems and rigid bodies behaviour. Fundamentals of dynamics of SDOF systems. A student must pass two homework, four tests on exercises and a test on theory.

Subject: STRENGTH OF MATERIALS 1 Faculty: Mechanical Engineering Department: Institute of Mechanics and Computational Engineering	
Studies: B.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter	36	18/+	18/+	—	—	—
ECTS points				4		

Author(s): Piotr SZURGOTT, Ph.D. Eng
Leading lecturer: Piotr SZURGOTT, Ph.D. Eng

CONTENTS

Geometrical characteristics of planar figures. Determination of reactions and internal forces in beams, plane frames and trusses. 3D orthogonal frames. Static tension test for metals. Conditions of load capacity and usability. Tension and compression of short and thick bars. Torsion of bars of the circular, ring and thin-walled cross-sections. Simple bending with the shear of bars of the rectangular, circular, ring and thin-walled cross-sections. Deflection line of bent beams.

EFFECTS OF EDUCATION

Theory and calculation methods for geometrical characteristics of planar figures, determination of reactions and internal forces in beams, plane frames, trusses and spatial frames. Fundamentals of the strength of materials. Strength analysis of machine elements in simple strength cases concerning internal forces, stress and strain. A student must pass four homework, four tests on exercises and one test on theory.

Subject: STRENGTH OF MATERIALS 2 Faculty: Mechanical Engineering Department: Institute of Mechanics and Computational Engineering	
Studies: B.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	42	16/+	20/+	6/+	—	—
ECTS points				4,5		

Author(s): Lt. Col. Piotr KĘDZIERSKI, Ph.D. Eng
Leading lecturer: Lt. Col. Piotr KĘDZIERSKI, Ph.D. Eng

CONTENTS

Spatial and plane states of stress. Spatial and plane states of strain. Hooke's law for an isotropic material. Failure theories for an isotropic material. Combined loadings. Displacements in simple beams and plane frames using the method of virtual work (the Maxwell-Mohr method). Statically indeterminate beams and plane frames - force method. Buckling of straight slender bars. Mechanical testing of materials (laboratories).

EFFECTS OF EDUCATION

The student is expected to possess knowledge in the following areas:

- analysis of stress and strain states in deformable bodies,
- strength analysis of machine elements subjected to combined loading conditions, including internal forces, stresses, and strains,
- determination of displacements in simple beams and planar frames using the Maxwell–Mohr method,
- evaluation of internal forces in statically indeterminate beams and planar frames,
- calculation of critical loads in the compression of straight, slender bars.

The student is required to pass two practical tests and one theoretical test.

Subject: FEM AND SIMULATION OF LINEAR PROBLEMS OF MECHANICS Faculty: Mechanical Engineering Department: Institute of Mechanics and Computational Engineering	
Studies: B.Sc. / M.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter/Summer	44	10/+	10/+	24/+	—	—
ECTS points				5,5		

Author(s): Wiesław KRASOŃ, Ph.D., D.Sc. Eng
Leading lecturer: Wiesław KRASOŃ, Ph.D., D.Sc. Eng

CONTENTS

Classification of linear problems of mechanics and methods for linear system analysis. Theoretical and computational aspects of finite element methods (FEM). Introduction to practical problems of linear FE analysis – typical algorithms of FE linear analysis. Examples from areas of linear elasticity, structural mechanics and design of machine components. Basic relations in FE analysis of truss structures. Spring elements-stiffness matrices. 2D and 3D finite elements. Modelling of structure and boundary conditions, FE analysis and the interpretation of the results for 2D and 3D structures.

EFFECTS OF EDUCATION

The purpose of this course is to describe simple methods for computer simulations, and the basic study of finite element methods. This feature is being used more and more by the engineering profession for analysis and design. The goal of this course is to demonstrate how FE methods work and how they interact with models. To obtain a passing grade the student must be able to: develop FE model of truss, beam structures and other simple 2D-3D FE models, evaluate both the accuracy and relevance of numerical results and write a short report on the features of numerical models and results' interpretation.

Subject: MULTIBODY SIMULATION IN MECHANICAL ENGINEERING	
Faculty: Mechanical Engineering	
Department: Institute of Mechanics and Computational Engineering	
Studies: B.Sc. / M.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter/Summer	36	10/+	8/+	18/+	—	—
ECTS points				4		

Author(s): Wiesław KRASOŃ, Ph.D., D.Sc. Eng
Leading lecturer: Wiesław KRASOŃ, Ph.D., D.Sc. Eng

CONTENTS

Classification of multibody problems of mechanics and methods for multibody system simulation (MBB). Theoretical and computational aspects of multibody analysis. Introduction to multibody dynamics: differential-algebraic equations and system with constraints, numerical integrations. Basic concepts for multibody simulation- simulation of unconstrained/ constrained mechanical systems. Modelling of multibody systems. Velocity and acceleration analysis in dynamic simulation. Introduction to practical problems of multibody analysis. MBB examples from areas of structural mechanics and design of machine components. Modelling of structure and boundary conditions, MBB analysis and the interpretation of the results for 2D and 3D structures.

EFFECTS OF EDUCATION

The purpose of this course is to describe simple methods for multibody kinematic and dynamic simulations, and a basic study of multibody methods. This feature is being used more and more by the engineering profession for analysis and design. The goal of this course is to demonstrate how such methods work and how they interact with models. To obtain a passing grade the student must be able to: independently perform planar models for multibody analysis, develop a 3D model of simple structures, evaluate both the accuracy and relevance of numerical results and write a short report on the features of numerical models and results' interpretation.

Subject: FUNDAMENTALS OF VALIDATION OF NUMERICAL MODELS Faculty: Mechanical Engineering Department: Institute of Mechanics and Computational Engineering	
Studies: B.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter/Summer	30	10/+	—	20/+	—	—
ECTS points				4		

Author(s): Grzegorz SŁAWIŃSKI, Ph.D. Eng
Leading lecturer: Grzegorz SŁAWIŃSKI, Ph.D. Eng

CONTENTS

Fundamental terms related to the validation of numerical models. The problems of numerical models validation. A review of the simulation method in mechanics. Methodology for the development of numerical models of materials and structures within a finite element method. Modelling and variant solutions for initial boundary conditions and loads. Validation methodology (authentication) for numerical models of the mechanical system. Validation tests and simulation experiment planning. Selected validation tests for tension and compression of bars, beams' bending, beams' torsion. Comparative analysis and validation of analytical solutions with solutions for different variants of numerical models within selected validation tests.

EFFECTS OF EDUCATION

Fundamental knowledge and skills within experimental methods and analytical calculations for authentication of the numerical simulations results for selected problems of mechanics. Ability to develop reliable numerical models of materials and structures within a finite element method, including modelling and variant solutions for initial boundary conditions and loads. Ability to compare analytical solutions obtained from scientific literature or obtained from the experiment with solutions for different variants of numerical models within selected validation tests.

Subject: NUMERICAL MODELLING OF MATERIALS	
Faculty: Mechanical Engineering	
Department: Institute of Mechanics and Computational Engineering	
Studies: B.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Summer	30	10/+	—	20/+	—	—
ECTS points				4,5		

Author(s): Danuta MIEDZIŃSKA, Ph.D., D.Sc. Eng
Leading lecturer: Danuta MIEDZIŃSKA, Ph.D., D.Sc. Eng

CONTENTS

The subject investigates relationships between the material's structure in the micro-scale and their macroscopic properties. Methods of numerical micro-scale and macro-scale modelling of modern materials are presented. Such computation can be used to investigate design materials in ways which cannot be achieved with experimental methods. The material structure models, the homogenization methods and the material constitutive equations, applied in commercial CAE software, are shown for selected materials. The numerical models are developed and analysed. The models are based on microstructure, as well as on the global properties of the chosen material. The methods that involve X-ray tomography are presented and investigated as well.

EFFECTS OF EDUCATION

Theory fundamentals and skills in methods of numerical micro-scale and macro-scale modelling of modern materials. The material structure models, the homogenization methods and the material constitutive equations, applied in commercial CAE software. The methods based on X-ray tomography. To obtain a passing grade the student must be able to: independently develop a 3D FEM model of the chosen advanced material, evaluate both the accuracy and relevance of numerical results and write a short report on the features of numerical models and results interpretation.

Subject: MANUFACTURING TECHNOLOGY	
Faculty: Mechanical Engineering	
Department: Institute of Mechanics and Computational Engineering	
Studies: B.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter	30	30/+	—	---	—	—
ECTS points				4,5		

Author(s): Danuta MIEDZIŃSKA, Ph.D., D.Sc. Eng
Leading lecturer: Danuta MIEDZIŃSKA, Ph.D., D.Sc. Eng

CONTENTS

The subject includes the theory of manufacturing technology processes. The following cases will be described: metals and metallurgy, chip machining (turning, drilling, milling, chiselling, broaching, grinding and other), abrasive and electro-erosion machining, gear machining, plastic processing, casting, welding, adhesive (glueing), plastics processing, 3D printing.

EFFECTS OF EDUCATION

Theory fundamentals and skills in methods of manufacturing technology processes, material properties in accordance to manufacturing ability. Advanced knowledge about metals processing, chip machining, casting, plastic processing, welding, plastic material processing and manufacturing techniques. The methods based on additive manufacturing – SLA, SLS, FDM. To obtain a passing grade the student must be able to: independently describe and project a manufacturing process in accordance with material properties and the final construction requirements.

Subject: NON DESTRUCTIVE TESTING TECHNIQUES IN ENGINEERING Faculty: Mechanical Engineering Department: Institute of Mechanics and Computational Engineering	
Studies: M.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
W/S	30	30/+	0	0	—	—
ECTS points				4		

Author(s): Andrzej LESKI, Ph.D., D.Sc. Eng
Leading lecturer: Andrzej LESKI, Ph.D., D.Sc. Eng

CONTENTS

Review of currently used techniques in non-destructive testing. For each method, the physical basis, principles of use, and the advantages and limitations of the methods will be discussed. The lecture is illustrated with examples of real research, mainly in the field of aviation. The classes will present the following NDT testing methods:

- eddy current
- ultrasonic
- X-ray
- penetrative
- magnetic
- D-sight
- shearography

EFFECTS OF EDUCATION

The student has basic knowledge in fatigue of non-destructive testing techniques.

The student knows the physical basics for each method. They understand advances and limitations of NDT. The student has knowledge about probability of detection (PoD).

Subject: EXPERIMENTAL TECHNIQUES OF MATERIALS AND STRUCTURES TESTING	
Faculty: Mechanical Engineering	
Department: Institute of Mechanics and Computational Engineering	
Studies: M.Sc.	Language: English

semester	form of duties, number of hours/ form of credit (x –examination, + –pass, # –project)					
	total	lectures	classes	laboratories	project	seminar
Winter	32	16/+	—	16/+	—	—
ECTS points				3,0		

Author(s): Paweł BOGUSZ, Ph.D. Eng
Leading lecturer: Paweł BOGUSZ, Ph.D. Eng

CONTENTS

Discussion of techniques utilized in experimental strength of materials and structures testing. Introduction to basic testing techniques, standards, universal testing machines, transducers, sensors, and measurement equipment used in experimental strength of materials and structures research. Determination of mechanical characteristics and constants of constitutive models of engineering materials under various static loading conditions. Determination of material characteristics in fatigue testing and energy absorbing tests. Fundamentals of electrical resistance strain gauge method. Basics of non-destructive testing in mechanical engineering.

EFFECTS OF EDUCATION

The student is able to plan and conduct experimental research in the field of mechanical engineering and materials strength. They are capable of planning and conducting static tests according to standards and determining basic strength parameters necessary for constitutive modeling. They are familiar with measurement techniques, strength testing machines, and measurement sensors, particularly with the electrical resistance method.

Furthermore, the student can think and act creatively. They are prepared to critically evaluate their knowledge and acknowledge the importance of knowledge in solving cognitive and practical problems.